UNIV. OF
TORONTO
LIBRARY

Digitized by the Internet Archive
in 2008 with funding from
Microsoft Corporation

http://www.archive.org/details/engineeringcontr54chicuoft

BINDING LIST MAY 1 5 1922

chnol
E.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LE EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

173032
20/7/28

Volume LIV. CHICAGO, ILL., JULY 7, 1920 Number 1.

Are Chemists Engineers?

At the organizing conference of the Federated American Engineering Societies no representatives of the American Chemical Society were present. The reason commonly assigned for this fact was that chemists are not engineers. Chemical and Metallurgical Engineering thinks that chemists should support this proposed federation. Nevertheless that magazine does not regard all chemists as being engineers, for it says:

> "Engineering" has been defined by enthusiasts to be as all-embracing as the official statement of scope of the Bureau of Standards: "The establishment of standards of measurements, constants, quality, performance and practice." A like blanket definition is that which regards engineering as "the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race." Evidently a sailor and a surveyor are both included—the wide reaches of engineering includes Generals Gorgas and Goethals!
>
> Obviously a more restricted meaning corresponds with usage, despite the enthusiasts. An engineer is rather an applied physicist, he who understands the laws of heat, electricity, light, sound, dynamics and statics and can make them useful to man in structures and machines. In this way the sailor and General Gorgas—indispensable though they be—are evidently and properly not classified with the surveyor and General Goethals.
>
> Now, is a chemist, "versed in the science of the composition of substances and their transformations," an engineer in this sense? If the chemist is a scientist—one intimate with the systematic knowledge of his subject—he evidently is not called an engineer, and rightly so, and it would be no less than a calamity to revise educational methods so that nearly all the students would graduate chemical engineers, to the exclusion of chemists. On the other hand, if he is more the artist—one whose knowledge is made efficient and useful to his neighbors by skill—then he would be welcomed into their fraternity by all engineers.

It will be noted that under the definition above suggested an engineer is an applied physicist, yet in the same editorial we read that "engineers are a group of educated men distinguished from scientists principally because the engineer applies science for human benefit." If so, we fail to see why the chemist who applies science is not an engineer.

A physician applies science—sometimes chemical, sometimes physical, and not infrequently psychological—yet he would not be classed as an engineer. It seems to us that the application of science is not the sole criterion of engineering. Engineering, as we regard it, is the systematic application of science to the problems of economic production and service. Under this definition falls the activity of any chemist who is engaged in solving economic problems. If, however, his work is not directly of an economic nature, it is not engineering.

An Amateur Economist Lectures the Governor of California on Highway Extravagance

This is the day of the amateur economist, the man who can solve any economic problem upon a moment's notice without the necessity of searching for data. Thus one H. W. Keller, speaking for the Automobile Club of Southern California, having learned that highway construction has doubled in cost reasons that the State of California should discontinue practically all road work until construction prices recede to the prewar level. He is so sure of his conclusions that, in behalf of the aforesaid club, he writes the governor of the state an impudent letter in which he accuses the governor of ignorant extravagance in continuing to build roads.

Gov. Stephens, who was formerly a practicing engineer, is doubtless well enough informed about prices and wages to know that there is slight probability that road building costs will recede much below the present level for many years to come. He also knows that good roads have done more than any other thing to accelerate the growth and prosperity of California. But Mr. Keller, who is apparently as ignorant of the causes of price changes as he is of the economic gains that follow road improvement, reads the Governor a lecture on extravagance.

In all likelihood there will be a referendum vote in California this fa[illegible] raising the rate of interset on state [illegible] the present 4.5 per cent to the necess[illegible] raise in the bond interest rate is ap[illegible] not it will be, it will indicate that th[illegible] want more good roads at present pr[illegible] willing to wait an indefinite but certainly [illegible] construction costs

Are Prices Affected More by Psychological Than by Economic Influences?

Must we look to the laws of economics or to the laws of psychology to understand changes in price levels? This is a question asked by Chemical and Metallurgical Engineering, to which this answer is given:

> Perhaps it is [illegible] as a rough generalization that the long swings are produced by economic influences and the fluctuations by psychological influences.

But what is an "economic influence" as distinguished from a "psychological influence"? The fact is that many of the laws of economics are laws of mental action. Take, for example, the economic law that the output of workers is influenced by the amount of pay received for their performance. Here it is evident that an economic law is either based on a psychological law, or is coincident with it. The same holds true of scores of economic laws. Indeed, it might almost be claimed that economics is a branch of mental science, so numerous are the economic laws that express mental characteristics. Almost the entire structure of the old political economy rests on the psychological principle that selfishness dominates the action of most men engaged in the production and distribution of wealth.

In discussing economic problems only confusion can result from any attempt to make it appear that economics is a purely physical science. It is, in fact, a complex of physical, mathematical and psychological principles.

What Is True of the Parts Is Not Necessarily True of the Whole

Apparently it is only with great difficulty that the average thinker becomes able to distinguish between an economic law or principle that relates to a society as a whole and one that relates only to a part thereof. One of the commonest of fallacies consists in inferring that whatever is true of any of the members of a society must necessarily be true of the society as a whole. This fallacy may easily be exposed by an illustration.

It is true that if any individual is able to double his money, he can command a greater amount of service or goods from his fellows; but if every individual were to double his money, no one would be able to command any more service or goods than prior to the doubling. A dollar is a ticket that calls for services or goods. Doubling these tickets in the possession of each person obviously can not alter any individual's share of services or goods.

One of our readers asks us to explain how population can affect price levels in the manner indicated in Mr. Gillette's average index price formula given in our April 7 issue. He says:

> No doubt this price [illegible] correct, yet how can this anamoly be explained? Value depends directly upon population. No population, no value. If the population of a town reduces to half, then about half the houses will be valueless. Yet Mr. Gillette's price formula indicates that prices vary inversely with population, instead of varying directly with it.

This is a good example of the confusion that so often occurs when reasoning about an economic principle that relates to a society taken as a whole. Mr. Gillette's price index formula gives the relative average wholesale price of all commodities in a given country, but our correspondent undertakes to apply it to houses in a given town. Mr. Gillette's price formula is:

$$p = \frac{M \times V}{2 \times C \times E}$$

In which M is total money, V is rate of annual turnover of money, C is total population, and E is per capita annual production of commodities. Hence C × E is total annual production of commodities.

Our correspondent undertakes to apply this formula to houses in a given town, but the formula was not deduced to apply to the conditions that he assumes. It was deduced to apply only to the average price of all commodities produced in a country whose total money supply is M, and whose population is C. In such a country if the population were cut in two, while the other factors (M, V and E) remained unaltered, average commodity prices would be doubled. The formula does not give the price of houses, or of eggs, or of steel, and is therefore not applicable to them taken by themselves.

Population added to a town may increase the value of its real estate, but it does not necessarily add anything to the price of the commodities sold in the town. Population added to a nation may increase the total land value therein, but without altering the average selling price of commodities.

There is another subtle fallacy in our correspondent's argument. He says: "No population, no value," which is true, for the cause of value is demand, and demand is nonexistent where population does not exist. But it does not follow that because the entire elimination of population eliminates all value, therefore a reduction in population causes a reduction in all values. With a reduction in population there occurs not only a reduction in demand for goods but a corresponding reduction in supply of goods.

In any interpretation of the significance of a formula, it is essential to realize that the formula merely expresses a quantitative relation between certain things, and that the conditions under which that relation exists are either expressly stated or tacitly assumed in deducing the formula. Hence it is irrational to test the truth of any formula by applying it to conditions that were neither assumed nor implied in the process of deducing it.

Concrete for Pavements

To the Editor: The immense amount of highway paving now being constructed and projected all over the country has been responsible for extensive laboratory tests of concrete mixtures, and many articles have been written by engineers from various viewpoints. The manufacturers of contractors' equipment are also developing their products to meet the latest requirements.

The state highway commissions are taking a lively interest in determining what kinds and details shall be adopted by them, and the general public who ship by truck or drive automobiles for pleasure are entering into the discussion and submitting their best judgment or guesses; the automobile and truck manufacturers, who know that they have some interest in the results, are offering statistics as to the value of good roads; and finally, the farmers and taxpayers are trying to determine whether they can afford to pay their share for paved roads.

Engineers are not taking advantage of this great opportunity to efficiently plan pavements for towns and public highways. Too large a proportion are admittedly or actually guessing and experimenting at the expense of the public, and the expense involved is large. This condition tends to shake public confidence (and it is already badly strained in spots) in the great advantage if not necessity of employing engineers to take responsible charge of all such work; and any weakness in one branch of the profession reflects upon the whole, in general.

The engineers should be dictating and directing the details of all this construction work, but as usual they are generally playing the part of the "necessary evil," and carrying out instructions. They are plainly not agreed upon any well defined and definite type and specification for such work. "Engineering and Contracting" has an opportunity to help to bring order out of chaos at this time by urging the engineers to assist themselves and by calling their attention to the definite knowledge and experience which we already have of concrete work. The most satisfactory results can only be obtained by utilizing this experience in determining upon specifications to best fit the conditions and material of each locality, and by the rigid inspection and eternal vigilance which is necessary to have the specifications carried out in detail.

All concrete construction is much like a chain of many links and it is only as strong, in giving satisfaction, as its weakest link or poorest section. But as yet many engineers who are in charge of work don't grasp this important truth.

We have known for years that certain lean mixtures of concrete are strong and dense enough for foundations which are buried from the atmosphere and have to resist only compression and low shear stresses, and we also know that richer mixtures properly reinforced are needed for concrete in building construction subject to bending, shear, compression, atmospheric changes and traffic abrasion. But when a concrete base for pavement is considered, all this knowledge seems to be overlooked, usually, as though it pertained to some other material and the indefinite experience which is available from concrete used for road work is used; and when this experience seems too unsatisfactory some new method or combination is guessed at or determined upon.

Maybe it is because concrete pavements seem to have the ground to support them, that they are considered as being separate and distinct from concrete which is used for building work. Of course that is the reason that so much improperly designed and constructed work has lasted as long as it has, but—

Whenever a poor section of sub-grade occurs at the same place as a poor job of concreting, the combination results in a definite failure, and concrete in general is apt to be condemned in that locality.

Whenever a comparatively level piece of very green concrete is left exposed to the weather and storms all winter, and it freezes and thaws several times, at least 1 in. of its surface and sometimes the whole depth will be completely shattered and useless by spring.

Whenever porous concrete base becomes water soaked and freezes often in that condition, it deteriorates and ultimately causes failure of the pavement in varying degrees.

Whenever concrete base is laid over improperly tamped pipe trenches, it is apt to break down or crack unless it has been reinforced with steel.

Whenever concrete surface is exposed to abrasion, it will wear best if finished smooth and if it is a dense rich mixture of hard aggregates only, and

A base which is thick enough on some kinds of soil and for light traffic may fail utterly on other soils or for heavy traffic.

The writer agrees with Mr. J. N. Mackall, Chief Engineer of the Maryland State Road Commission,* as to the desirability of concrete for highway pavement because "it will wear from 7 to 20 years under heavy traffic, if properly mixed and laid, at very little maintenance cost; and when it can no longer be maintained economically as a concrete road, it can be resurfaced with some form of hot mixed bituminous pavement or brick, thus conserving the entire initial investment."

Many miles of brick pavements on very questionable concrete bases are contracted for now, with engineering approval, in localities where brick are comparatively expensive and hard to get and good concrete materials are much more available and inexpensive.

Such work should always be planned and carried out in detail under the supervision of engineers who have the assurance and knowledge, based on sufficient experience, of what is necessary and best; because wasteful requirements which eliminate concrete on account of first cost are often demanded in one locality, while somewhere else, specifications and workmanship which cannot produce good concrete, but which do serve to condemn it for that locality, are permitted. The engineers are to blame and the public interest suffers.

For instance, we have standard specifications in one state for a 6-in. concrete base to be mixed in the proportions of 1 part cement and 6 parts of "sand-gravel" aggregate, and the specifications of a state directly adjoining it requires the same concrete base to be mixed in the proportions of 1 part cement to 3¼ parts of unscreened gravel when it (the gravel) grades the same as in the first instance.

This is a very good example of the evident lack of definite knowledge on the subject by those who are supposed to be experts and who undoubtedly swerve public opinion.

The Iowa Highway Commission issued a "field manual for its concrete inspectors" which is probably as complete and practical for such purposes as anything in use [illegible]. But the methods of inspection in some other [illegible] by the engineers who are in charge of large amounts of municipal work throughout the Middle West at least are lamentably lacking in even "horse sense" precautions. Poor subgrade, working in cold weather without protecting the horizontal surfaces from the weather and from traffic long enough, and careless mixing, are all reasonably sure to cause failures in either base or finished surface even though the plans and specifications are all-right.

In reinforced concrete building construction, we have had approximately 20 years of definite and extensive experience with the use of concrete made in all shapes, and to withstand all kinds of stresses, including impact, abrasion and heavy trucking. This work has failed in many instances and degrees and many buildings have been torn down which did not fall. This work has also been done successfully above water and below water, on all sorts of foundations and in all kinds of weather and temperatures. As a result of this experience we have today building codes in all of our principal cities which prescribe in minute detail how this work shall be designed and constructed, and what the limitations shall be as to stresses. These requirements are all remarkably similar now and thus show that the results have been generally accepted as satisfactory by the engineering profession.

Eliminating the requirements for fire protection, the stresses in concrete for highway pavements are all of the same nature as in buildings, excepting that they are often more severe and uncertain because of the range of temperature, saturation from wet ground and rains and subgrade movements. Consequently if any difference is desirable in this concrete it should be proportioned and placed with even greater care and precaution.

It is sometimes argued that there is a great deal of difference between concrete for building construction and concrete for highways, but why not define that difference so that we can prepare for it or at least expect it? Only very recently, a truck containing 15 tons of sugar which was being transported from New York to Philadelphia drove onto a coal and feed scale and broke it. Highways have no protection against such excessive loads while buildings ordinarily do have.

Because concrete for highway work should be if anything better than that used for building construction, it would seem inexcusable for paving engineers to start out so often by using or experimenting with concrete which would not be permitted for building construction. It may be true that "the testing engineers of state highway departments have been getting together recently and it is expected that more uniform specifications will soon be arrived at," but in the long and expensive meantime why not use the experience gained from successful building construction and why not make it the starting point for laboratory tests and specifications for our highway work?

The big thing now, evidently, is to improve on what we already have with as little waste of time and expense as possible. This is what the public wants and it is what the engineering profession should do. It is probable that the public would appreciate and rely upon engineers more generally if they always did things in the most direct and efficient manner, or at least in accordance with the knowledge and experience available.

Highway contractors will appreciate prompt and constructive action in this matter; they are annoyed by so many different specifications and they are often held at least morally responsible for the results of the engineering blunders involved. The popular magazines inform us how little we know about electricity, but we use that little very effectively. It is evidently up to the engineering magazines to remind us how much we know about concrete and to suggest as forcefully as possible that we use it wherever it is needed.

ALBERT C. AREND,
Consulting Engineer.

Omaha, Neb.

Engineers' License Law Proposed for Ohio. A proposed engineers' license law will be considered by the engineers of Ohio at a meeting in Columbus on July 9th, according to a notice issued by C. L. Rood, president of the Association of Ohio Technical Societies and president of the Ohio Assembly of the American Association of Engineers.

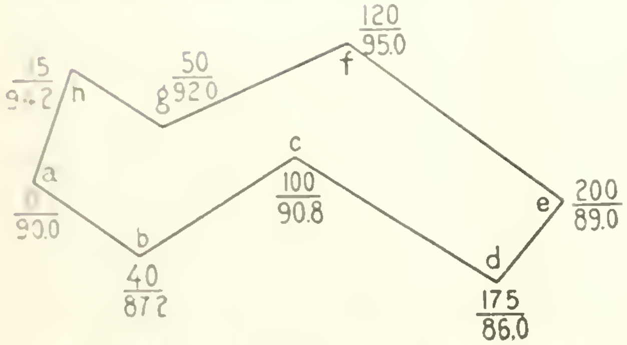
---

*Engineering News-Record, May 6, 1920.

A Time Saving Method of Computing Cross Sections

[illegible] field engineer's [illegible] A convenient [illegible] which is [illegible] an exper[illegible] 6 miles [illegible] G. T. [illegible] Public Roads [illegible] the matter fol[illegible]

[illegible] familiar with the [illegible] will probably recognize [illegible] areas by latitudes and [illegible] for the computation of [illegible] generally recognized. The time re[illegible]



[illegible]

(0 + 40) × 2.8 = 112.0
(100 + 175) × 4.8 = 1,320.0
(120 + 50) × 3.0 = 510.0
(15 + 0) × 4.2 = 63.0

14.8 2,005.0

Fig. 1—Computation of Borrow Pit Area.

[illegible] cross sections by this process is remark[illegible] the volume of work that can [illegible] correspondingly large, so whether the [illegible] or not it is worthy of much more [illegible]. This method can be used in computing [illegible] complicated figures as readily as that [illegible]

[illegible] cross section as, for instance, one [illegible] pit. Before any excavation is taken [illegible] of course, be run over the area from [illegible] be taken. Let it be assumed that the [illegible] run, are as follows

[illegible]

[illegible] be taken on the other [illegible] important feature of this sys[illegible] of entire indifference, so far as [illegible] is concerned, as to [illegible] whether they are equal dis[illegible] there is any means pro[illegible] stations. The [illegible] excavation shall fall [illegible] and that [illegible]

[illegible] new elevations [illegible] resulting

[illegible]

The two sets of elevations over the course form the figure,

a	b	c	d	e	f	g	h	a
0	40	100	175	200	120	50	15	0
90	87.2	90.8	86	89	95	92	91.2	90

which is a closed figure. The area of this figure may be computed from any point in the series, but for ease in computation and because this is the general procedure, the zero point will be selected.

The area is computed by taking one-half of the algebraic sum of the products resulting from the multiplication of the sum of the horizontal distances from the zero point, assumed, to each end of each of the boundary lines of the cross section by the differences in elevation of the two ends of the respective lines, considering the products derived from descending lines as negative, and those from ascending lines as positive. There, therefore, result two columns of quantities, one a negative column, the other a positive column. Thus, turning to Fig. 1, we have for line ab (0 + 40) × 2.8 = 112, which is placed in the negative column because elevation 87.2 is less than elevation 90, and therefore this line is a descending line. From station 40 to station 100, which is line bc, we have (40 + 100) × 3.6 = 504, which is placed in the positive column because this line is an ascending line. Descending from station 100 to station 175, we have (100 + 175) × 4.8 = 1,320, which is placed in the negative column. Then from station 175 to station 200, which is an ascending line, we have in the positive column (175 + 200) × 3 = 1,125. Returning from station 200 to station 120 we ascend, and therefore place in the positive column (200 + 120) × 6 = 1,920. Descending to station 50 we place in the negative column (120 + 50) × 3 = 510. Ascending again from station 50 to station 15 we have (50 + 15) × 2.2 = 143, to place in the positive column, and finally from station 15 to station 0, the point of beginning, we have (15 + 0) × 4.2 = 63, which is placed in the negative column because this is a descending line.

As these members are set down they are usually written in two columns as shown in Fig. 1. As a check on the accuracy with which the quantities have been taken off, the multipliers in both columns should be added, and if the differences in elevation have been correctly calculated the sums of the positive and of negative side will be equal. In this case the multipliers total 14.8 on both sides. Adding the products we have 3,692 on the positive side and 2,005 on the negative side, the difference being 1,687. One-half of this is 843½, which is the area of this cross section. It should be clear at a glance that the final result of this process is, as stated above, entirely independent of the number of stations appearing between station 0 and station 200, either in the original survey or in any subsequent survey. It is not necessary that the stations, other than the first and last, have any other relation te each other than that they appear on the same line. From this it should be clear that this method is of particular advantage in cross sectioning borrow pits, as it is not essential that any points be preserved in the area where work is being carried on. Indeed all levels may be taken at the most advantagous points and at those points which will tend to promote the greatest accuracy in the final result, regardless either of preceding or of successive work. This system is, therefore, peculiarly adapted to field conditions. Moreover, owing to the simplicity of the calculations any desired degree of refinement may be secured, for any increase in the number of stations occupied merely serves to increase the number of computations per cross section, but in no way increases their complexity.

Finally, the system is so simple that it can be taught to any one who can add and multiply. This is an important matter, for it enables the chief of party to train his subordinates—even the brighter rodmen and axmen to compute cross sections quite as accurately as he can do it himself.

The application of the method to the computation of the areas of road cross sections involves processes which are similar to those which have already been described for the calculation of borrow pit areas. In this case, however, it is convenient to assume as the zero or reference point the center of the subgrade. In doing so, however, to avoid negative areas it is necessary to proceed around areas to the right of the center in an anticlockwise direction, and areas to the left in a clockwise direction. When the area is entirely in excavation or entirely in embankment, or when, on side hill sections, an area of excavation or embankment crosses the center of the road, it is necessary to consider the parts to the right and left of the center as separate areas and to bear in mind the injunction as to direction else the correct area will not be obtained.

Figure 2 illustrates the method of computing the areas of excavation and embankment in a sidehill section. In the computations set down above the figure it will be observed that the parts of the area of excavation on the right and left of the center, respectively, are considered as separate areas and that the algebraic signs of the partial products are determined by proceeding in the anticlockwise direction around the part to the right and in the clockwise direction around the part to the left of the center. Similarly the area of embankment which lies entirely to the left of the center is encircled in a clockwise direction.

As set down above the figure the computations are necessarily extended by the inclusion of the multiplications, the products of which are zero. In practice, these can be determined by inspection and omitted. A further saving in time and labor results from the recognition of the fact that a constant road cross section yields a constant difference between the positive and negative products which result from progressing from the center reference point to the edge of the shoulder. Thus on the excavation side the products to this point are:

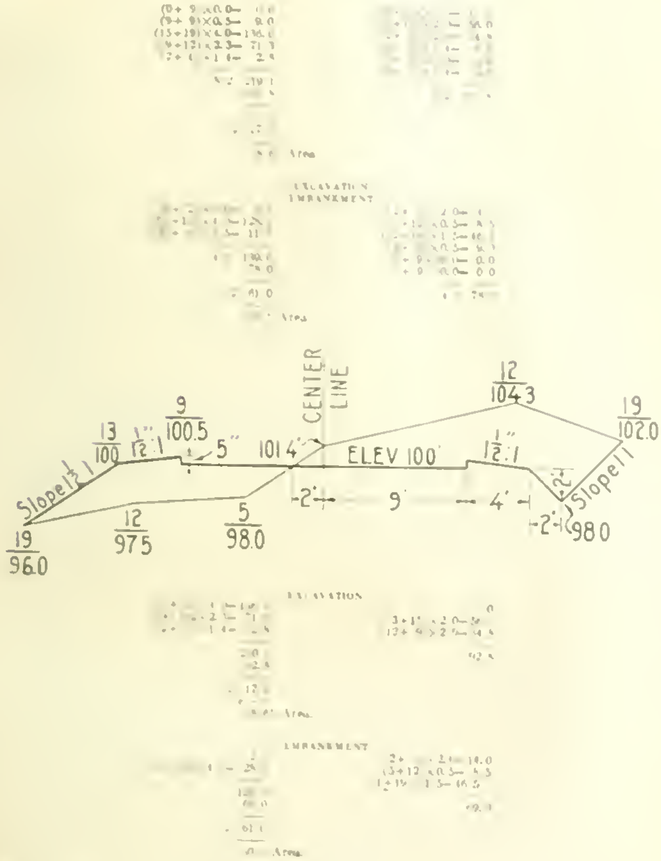


Fig. 2—Method of Computing Areas of Excavation and Embankment in a Sidehill Section.

PLUS.	MINUS.
(0+9)×0=0.0	(0+1[illegible])×[illegible]=11.0
	11.0
(9+9)×0.5=9.0	9.0
9.0	Difference 2.0

On the embankment side, beginning at the shoulder and proceeding in a clockwise direction to the center, the products are:

PLUS.	MINUS.
(13+9)×0.5=11.0	(9+9)×0.5=9.0
11.0	(0+9)×0=0.0
9.0	9.0
Difference + 2.0	

The difference is 2.0 in each case, but for areas to the right of the center it has the negative sign and for areas to the left of the center the quantity is positive.

Such a constant may be determined for any given cross section, and thereafter the computation of the areas may be simplified by following the form shown under the cross section in Fig. 2.

Commercial Sizes of Broken Stone and Broken Slag for Highway Construction

Tentative specification covering the standard size designation and maximum permissible range in mechanical analyses for nine commercial grades of broken stone and broken slag, when used in the construction of plain or bituminous macadam, bituminous concrete, sheet asphalt and cement concrete roads and pavements, were submitted at the last annual convention of the American Society for Testing Materials by the Committee on Road Material, of which Prevost Hubbard, 25 W. Forty-third street, New York City, is secretary. The main features of the proposed specification follow.

Manufacture. The standard sizes specified may be produced from the run of the crusher by means of any screening process in which the factors influencing the efficiency of the screening operation are so adjusted that the designated sizes will conform to the requirements for mechanical analysis specified below.

Standard Sizes. Each of the standard sizes shall be designated by reference to both the upper and lower nominal limiting size of the product; thus, "¼ to ¾ in. size" indicating that portion of the product of a crusher, all of which is nominally between ¼ and ¾ in. in size.

Permissible Variations in Mechanical Analysis. The designated sizes for each grade together with the corresponding maximum permissible variations in mechanical analyses as determined by the use of laboratory screens, are given in the following table:

MAXIMUM PERMISSIBLE RANGE IN MECHANICAL ANALYSIS FOR EACH SIZE

Percentage of weight passing laboratory screens—Diameter of screen openings, in. ¼		¾	1	1¼	2½	3½	Designated size, in.
85-100	.						0-¼
[illegible]-75	95-100						[illegible]
10-80	. .	95-100	. .	. .			0-¾
0-15	25-75	95-100	.				¼-¾
[illegible]-15	.	65-85	.	95-100			¼-1¼
[illegible]	.			25-75	95-100		¼-2½
	. .	0-15	25-75	95-100			¾-1¼
	. . .	. . . . .	. . .	0-15	95-100		1¼-2½
	. . .	.	.	.	0-15	95-100	2½-3½*

*In the case of light or porous slags a 1-in. maximum size may be specified instead of 3½-in.

Size of Samples. Samples of broken stone or broken slag which are to be examined to determine conformity with these specifications shall weigh at least 50 times the weight of the largest piece therein and be strictly representative of the product sampled.

Explanatory Statement. The commercial sizes designated in the accompanying proposed specifications provide primarily for the separation of the run of crusher into five sizes not including the 0-½-in. size. Although the limiting sizes were determined after carefully considering the size requirements of the various types of roads using broken stone or slag, no definite requirements regarding use have been inserted, as such requirements will be included in specifications which are to be prepared by the committee.

It will be noted that a general tolerance of 15 per cent on the lower limiting size and 5 per cent on the upper limiting size for each grade is specified. It is felt that this will cover all unavoidable variations in grading of a given designated product. An intermediate size requirement of from 25 to 75 per cent is also given for the ¼ to ¾ in. and ¾ to 1¼-in. isezs. It is felt that for the two larger sizes an intermediate size requirement is not necessary. For the combination sizes which will ordinarily be used in cement-concrete work, a lower tolerance of 5 per cent is specified. In the following table various uses to which the different grades are adapted are indicated:

VARIOUS USES FOR WHICH THE DIFFERENT GRADES OF STONE ARE ADAPTED

Designated size, in.	Suggested Uses
0-¼	For fine screenings for waterbound macadam.
0-½	For fine aggregate for bituminous concrete.
¼-¾	For dustless screenings or chips for bituminous macadam or bituminous surface treatment.
¾-1¼	For coarse chips or 1-in. stone for bituminous macadam.
1¼-2½	For wearing course, waterbound macadam or bituminous macadam.
[illegible]	For broken stone base course.
	Combination Sizes.
[illegible]-¾	For coarse screenings for waterbound macadam.
¼-1¼	For aggregate for reinforced concrete, bituminous concrete, sheet asphalt binder course.
[illegible]-2½	For coarse aggregate for cement-concrete roads and structures.

Improvement and Maintenance of Earth, Clay and Sand Roads*

By A. R. Hirst

[illegible]

[illegible] the various locations [illegible] the composition of [illegible] of man, will [illegible] in the United States a very [illegible] of the total highway mileage. [illegible] a very large share of [illegible] improved county highways [illegible] highways and national highways. [illegible] of national highways, systems of [illegible] systems of city highways [illegible] improved with adequate surfacing [illegible] systems, and practically all [illegible] come will be, earth roads. Their [illegible] the natural soil as deposited by nature or as modified by man.

Sand Clay Loam Makes Ideal Earth Road.—[illegible] of these [illegible] mixed by nature exactly right, so that [illegible] maintained with drags, road planers, or road [illegible] and give for a large percentage [illegible] adequate and excellent service. These roads are [illegible] soils which have been called sand clay [illegible] texture is not so sandy that it gives a surface which [illegible] readily, and not so clayey that it gives a surface which [illegible] slippery and ruts badly or holds water in wet seasons. On roads of this class, given proper drainage and a proper cross-section, maintenance is a simple matter. The intelligent and persistent use of an adequate [illegible] as soon as possible after each rain and a [illegible] amount of care to keep the ditches and waterways clear will insure a road structure adequate in many places [illegible] moderately heavy traffic.

Lighter than the loams above described, are the sandy loam soils which should be treated in the same general manner, but which on account of their more unstable character, [illegible] require light applications of clay in order to keep them from getting mealy. Where such roads are not standing up after proper regrading and proper maintenance, clay of a proper character should be added in small quantities, [illegible] two at a time, and the surface worked and reworked until stability is secured.

[illegible] the scale are the roads consisting of actual [illegible] which are totally hopeless if not properly [illegible]. Unless a real improvement is to be made on a sand road, the less it is disturbed the better it will be. Nothing is more [illegible] than to try to pass over a piece of sand road which has been recently graded or smoothed so as to [illegible] several inches deep with loose dry sand. Until funds are available to do something worth while with these roads they should be left severely alone.

There is one exception to this general rule. Quite often there is a [illegible] deposit overlying the real sand. In many [illegible] roads are sandy because this top soil has been [illegible] worn out and the use of a road machine to [illegible] soil from the sides to cover the worn-out [illegible] wonders. But don't cut through into the [illegible]. The top soil only is of value.

Improvement of Sand Roads by Fibrous Covering.—If it [illegible] available with the funds, sand roads should be [illegible] with a blade grader and a [illegible] covering of some fibrous material should then be applied. Cedar bark or cedar shavings, marsh hay, rye straw and [illegible] have been used for making these [illegible]. The material should be spread to a [illegible] which has been opened [illegible] thrown out should [illegible] the fibrous material [illegible] pro- [illegible] Our experience is [illegible] last at least [illegible] exposed to the [illegible] handled and [illegible] except on very [illegible] boulevard but [illegible] expense.

Tar Mat Experiment. [illegible] tried in [illegible] building of [illegible] marsh hay or rye straw impregnated with tar. We tried several methods of doing this, but found that the best method was to open the trench, spread about 4 in. of marsh hay carefully, apply ½ gal. of tar, cover adequately with sand; then spread a similar thickness of marsh hay, cover with ½ gal. of tar, and again with sand. We were able to build up in this way a fairly resistant mat which, on a road of moderate traffic, gave excellent service for over a year. Marsh hay produced somewhat better results than rye straw. While these tar mats give excellent surfaces, they were too expensive for the length of service secured. Such a covering would cost, at present prices, probably at least $1,000 per mile for a surface 16 ft. wide.

Sand-Clay Construction.—We, therefore, gave up the idea of using tar mats and have devoted all our energy to covering sand with clays and gravels. We find that the application of 3 to 5 in. of good binding clay, well mixed with the sand will if properly mixed and maintained, give in a very few months a very satisfactory road on even the deepest sands. The cost per mile varies, of course, with the distance of the clay deposit from the road, but we are convinced that it is a much better investment to cover sand with clay or gravel, almost regardless of cost, than it is to bother with temporary fibrous surfacings. Clays used in modifying sand roads should be clays which, when made into balls and dried until hard, will not dissolve too quickly when immersed in water. Usually, the longer the period necessary to dissolve the clays the better the clay for use in combination with sand, provided always that the clay as it occurs naturally can be pulverized when dry and mixed with sand.

Improvement of Moderately Heavy Clay Soil.—Going up the scale from the ideal earth road (the sand clay loam) we come next to the moderately heavy clays—clays which rut rather badly, but which do not usually become excessively slippery. These clays should be drained and given a proper cross-section, and then if they verge upon slipperiness after rains, should be given light treatments of sand until the texture of the surface is such that it can be traveled in wet spells without sliding all over the crown.

In general, the result is practically the same as upon the clay impregnated sandy loams, but the clays are more difficult to maintain, because the drainage conditions are worse. Given sand applications from time to time until the proper surface is secured, they make quite satisfactory roads.

Surfacing Heavy Clays and Muck Soils with Sand.—The next and final class is the heavy clays and mucks. These and the loose sands constitute the real "enfants terribles" in the earth-road family. Given a proper application of a smoothing tool the other three broad classes of earth roads will give good service. But nothing in the way of smoothing will make wholly adequate a road of real sticky clay or muck which is rough and dusty in dry seasons, a quagmire in wet seasons and a nuisance at all times. These roads should be especially well drained and be graded to adequate widths, at least 30 ft. between the ditches. The ditches should be cut well below the crown and the top of the grade should be quite flat. Places often becoming impassable should be carefully graded and well drained, either with stone drains or tile underdrains. It is often a very small percentage of the total length that renders clay roads impassable at certain times. The adequate treatment of this small percentage will often make a wonderful improvement in the general condition and passability along their whole length.

If a satisfactory earth road is to be secured upon these soils it is, in our opinion, absolutely necessary to surface them with sand or sandy gravel. Surprisingly light applications of these materials will remove the slipperiness and make smoothing with a plane or road grader effective.

We have converted many, many miles of heavy clay roads, previously practically impassable during every wet spell, into boulevards for a large fraction of the year with the surface application, usually at separated periods, of a few inches of sand. The amount of sand required will vary almost directly with the stickiness of the clay, and the amount of sand it will absorb without getting mealy.

Experiment only can determine this in each case, but, as a usual thing, to get a maintainable surface will require several applications totalling from 1 to 6 in. of loose sand. These applications are placed on the well graded and well compacted surface and are not mixed with the underlying clay at the time of application. Nature and constant smoothing will do the rest. The clay will finally come up from below sufficiently to properly bind the sand.

---

*[illegible] on.

Maintenance the Key to Earth Road Situation.—I have sketched, very briefly indeed, the general treatment of earth roads of the various classes in order to make them maintainable. None of these suggested improvements will make a good earth road unless they are immediately supplemented by an intense system of patrol maintenance. I have reached the conclusion that outside of the benefits derived from grading hills and getting proper widths and proper drainage it is almost a waste of money to treat earth roads unless their surfaces are afterwards modified to make them maintainable and they are then patrol maintained.

Maintenance is the key to the whole earth road situation. Without patrol maintenance, good earth roads are not possible, no matter what care is taken in their construction. Good drainage structures, good ditches, adequate cross sections and even good tile drainage will fail totally to provide a good earth road surface unless that surface is naturally maintainable or is modified so that it can be maintained and is then maintained.

Our system of patrol maintenance of 7,500 miles of state trunk highways in Wisconsin, and our county systems of patrol maintenance of an additional 5,000 miles have been a revelation not only to the people of the state, but also to the State Highway Commission and the County Highway Commissioners. In the short period of two years we have been able to effect a wonderful improvement in the general condition of our earth roads. In fact, the improvement made at small cost by using the above methods is almost unbelievable even to those who helped to produce it.

Cost of Patrol and Gang Maintenance.—The roads which are being maintained are the most important roads in the state. Upon them the traffic is heavy. The Wisconsin cost of patrol maintenance is large, the present cost being about $175 per mile per year. The gang maintenance, including the regrading, widening and the more extensive applications of surface modifying materials, totals an additional $125 per mile per year, on the average. This gang maintenance is practically construction work done on a comparatively small mileage of road at bad sections, but its total cost divided by the total mileage maintained gives the above average of $125 per mile. The patrol maintenance of roads of lesser importance would cost less per mile because the traffic would not cut them so deeply and so great widths would not have to be maintained, and thus the patrolmen's sections could be well extended. Our team patrol sections on earth roads vary from 6 to 9 miles in length, according to the character of the road, and the intensity of traffic. The average length is about 7 miles.

Limitations of Earth Roads.—It must be remembered, however, that while earth roads constructed and maintained in general accordance with the standards given above will give good service during the period between the date when frost is fully out of the ground and the roads have dried and settled and the time of heavy snows, they are not at all adequate for heavy traffic in prolonged wet seasons or in the spring.

No care in construction or in maintenance will make the ugly duckling into a swan. Given all possible care in their preparation for maintenance, given the best possible maintenance in the final analysis earth roads are just earth roads, and especially on clay soils, can never be made to stand the heavy concentrated traffic on main highways during the spring break-up or during prolonged wet spells. On less important roads where traffic is light to moderately heavy they will serve quite adequately all purposes during practically all seasons, if they are well maintained.

Gang Maintenance Grading Methods.—It is, of course, ideal, if the proper grading and draining frequently mentioned above as being necessary before an earth road can be properly maintained, can be done to the final profile and cross-section, and it is equally desirable for the culverts and bridges to be built of the final type so that, no matter what changes may later occur in the surfacing upon the road, the roadbed proper and its drainage structures will be adequate. However, it is not often that this can be done over the whole mileage which should be instantly maintained. Each year all of this kind of permanent grading work should be done that it is possible to finance and to build, taking the worst stretches first and doing well what is done on the proper locations and to the final grades.

Pending the time that this final grading work can be completed for the whole mileage, it is not necessary to throw up one's hands and say that nothing can be done on the stretches not fit for maintenance and for the grading of which no adequate funds are available. Wonders can be performed on even the worst stretches of road by intelligently reshaping them with a heavy blade grader drawn by a good stout tractor. Temporary drainage structures can be used where necessary. Where no dirt is available from the sides, some slushing or wheeling may be necessary to raise and widen certain of the fills.

We call this kind of work gang maintenance in Wisconsin, and do hundreds of miles of it annually at a cost of from $150 to $500 a mile, and at an average of probably $250 a mile under our present conditions as to wages, etc. Such work does not give the final roadbed, but it does give a maintainable roadbed, which can be kept safe and passable and which will serve quite adequately until funds are available for the final grading necessary before the permanent surfacing is applied.

Cutting and filling done to the nearest tenth of a foot is not a prerequisite to the maintenance of a good earth road. Fair widths, good shape, and good drainage are necessary. These can be secured very cheaply and rapidly by the use of the methods broadly outlined above. There is required only good judgment, a few good men, a good heavy road machine and a reliable tractor with adequate power.

One other point should be distinctly accentuated, and that is that the traveled way of well-constructed earth roads, when patrol maintained, should be given a very slight crown. Excessive crowns are not necessary if earth roads are kept smooth. In general, the less the crown, the better the result will be. We believe that during the summer season a crown of not to exceed 1/3 of an inch to the foot is ample for any earth road, and that as it approaches its going into winter quarters the crown should be increased to not to exceed 3/5 of an inch to the foot. The time when heavy crowning was considered to be the acme of earth road perfection, is past. The portion of these roads which is to be traveled should be almost flat, but must always be kept smooth.

Conclusions Regarding Earth Roads.—Based on our Wisconsin experience and our highway experience of nearly 17 years, we believe we are safe in stating the following conclusions in regard to earth roads:

Earth roads will, for all time, comprise the largest fraction of our road mileage, therefore their intelligent construction and maintenance is of paramount importance.

They should be given a proper cross-section adjusted to the soil of which they are made, and to the drainage conditions prevailing, as rapidly as the funds can be made available for the work. Gang maintenance grading methods should be used where funds are not available for the final grading.

They should be well drained by providing them with proper ditches, waterway structures of adequate size and blind stone or tile drainage where necessary.

The most adequate attention should be first given to the real road terrors—these sections upon which traffic is constantly being stuck. These sections constitute an astonishingly small percentage of the total mileage of earth roads and cause an astoundingly large percentage of the traffic troubles on earth roads.

The grading and graining of earth roads is of little value unless it is immediately supplemented by an intensive system of patrol maintenace.

The surfaces of many earth roads should be modified by applications of the proper material if they are to be properly maintainable, and are to give efficient service.

These modifiers are, for sand roads, clay or clay gravels, and for clay roads, sand or sandy gravels.

Given proper drainage and the proper modification of the top surface, earth roads will give good satisfaction during the summer traffic season on roads carrying almost an indefinite amount of traffic.

They will, however, if on clay, fail to give service on very heavy traveled roads, and practically on all other roads during the spring break-up and during prolonged wet seasons when their surface cannot be given effective smoothing.

The maintenance of earth roads should take the form of patrol maintenance, a man and team or a man and a motor truck being given a specific section of road for the condition of which section he is made solely responsible.

The best tools for the maintenance of earth road surfaces are (1) The [illegible] grader, and (2) the Minnesota or the Wisconsin [illegible]. Splitlog and other forms of drags should [illegible] because they go down into every transverse [illegible] and up on every transverse ridge and [illegible] these defects instead of removing them. Planers with long longitudinal bearings and road graders with long wheel bases remove these humps and depressions [illegible] practically as cheaply as the [illegible] drags.

Very [illegible] should be used on the traveled way of all earth roads. Practically flat surfaces can be patrol maintained. They should be maintained flat until the road has to be made ready to go into winter quarters, when the crown should be [illegible].

Most of the [illegible] for earth road surfaces to make them more maintainable and more passable are slow processes. Additions of material are best made a little at a time and then worked, mixed and kept smooth, additional material being added as necessary until a maintainable surface is finally secured.

Skill, patience and a large amount of religion are needed to cope successfully with earth roads. Given these requisites wonders can be performed with them.

It is a poor highway official or a poor highway system which leaves earth roads to care for themselves, while all time, all attention and all money is expended upon the construction of a few miles of surfaced highway.

We are firmly convinced, that in practically any unit of government, given the alternative of expending all of the highway funds available in regrading and draining earth roads, and in the modification and maintenance of their surfaces, or of expending all of the fund available in the construction of a few miles of surfaced roads, the people of the unit of government will receive much more benefit if the money is expended in the regrading, draining, modifying and maintaining.

This does not mean that I believe that construction should be neglected. It must be pushed as fast as it can be financed, but the speed of construction can well be retarded, if necessary, to provide for the proper maintenance of all important roads.

It is not conducive either to religion or to economic transportation to pass traffic over several miles of adequately surfaced highway, and then still it in a sea of mud or swirl of sand a few feet from the end of the improvements.

The text of this discourse is, "Maintain Your Earth Roads." Build adequately surfaced roads as fast as you can afford to [illegible]. For those roads which are not good and which you cannot afford to make good, at least do your level best. Give them a proper cross-section, proper drainage and a proper surface, and then give them the proper chance to do effective work by keeping that surface smooth and that drainage [illegible].

Anyone can take $50,000 and with it build a mile or so of [illegible] road, but it takes brains and care to take the $50,000 and give the community 170 miles of traveling earth surfaces, good the first year and growing better each year the $50,000 [illegible].

Asphalt Block Paving in Tampa, Fla.

As a result of the excellent showing made by asphalt paving blocks [illegible] 10 years [illegible] on more or less heavily [illegible] streets, and on which there has been practically no [illegible], the city of Tampa, Fla., has adopted [illegible] asphalt paving blocks as a standard paving material. [illegible] sq. yd. of these asphalt paving blocks are being laid in Tampa [illegible] streets or to extend [illegible] improved [illegible]. The procedure adopted is to [illegible] and laying of the block, the [illegible] into the work. A [illegible] in size, is [illegible] to the job to bring the street up to grade. The [illegible] wet and then rolled with a [illegible] roller.

A [illegible] of sand [illegible], after which the asphalt blocks [illegible] surface of 5 in. by 12 in. are laid [illegible]. [illegible] are driven together laterally and [illegible] to obtain a tight joint, and the entire [illegible] lightly.

Iowa Practice in Providing Detours

When the traveling public is seriously inconvenienced in using, or is entirely blocked from using any road on account of construction or maintenance work on such road or its bridges, it is necessary that some provision be made to detour the traffic around this impediment. A user of the highway is entitled to a fair warning of impassible construction or repair work. He should receive this warning at the point where he will be forced to leave the main road to avoid the obstruction. He should be directed as to which way to turn and at each succeeding intersection, he should be further directed until he has passed entirely around the obstruction and is again on the road he wishes to travel. He is not only entitled to these directions, but he is entitled to a fair road to travel upon which following them. Some excellent suggestions on how to obtain these desirable results are given in a pamphlet issued this spring by the Iowa State Highway Commission. Extracts from the pamphlet follow:

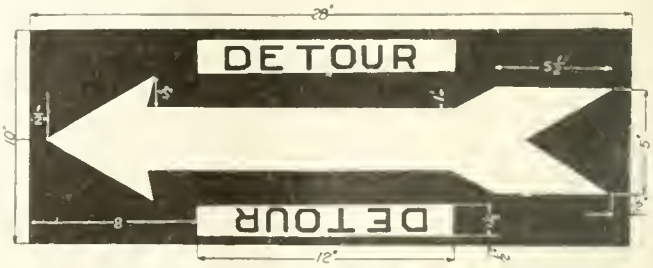


Fig. 1—Standard Detour Sign of Iowa Highway Commission for Directing Traffic to Right or Left.

Standard Detour Markers. The Iowa Highway Commission has adopted a standard detour sign which may be procured by the counties for use on all detours on either county or primary roads. This sign may be paid for either as primary road construction or maintenance work. Fig. 1 shows this standard design. This sign may be used to direct traffic either to the left or to the right. Fig. 2 shows typical signs. It is desirable to show the highway symbol or primary road number as well as the name of the town to which the detour leads. As this symbol and town name will be different for each detour, it will be necessary to have this work done by a sign painter. The word "detour" which is printed upside down below the arrow should be painted out in all cases. It is planned to have these signs printed on six-ply circus paper. It will be necessary to fasten them to boards slightly larger than the signs. Either a metal nailing strip or a wood cleat should be used for this purpose. After the sign has been properly adjusted to the board, it should be painted with a coat of linseed oil or hot paraffine.

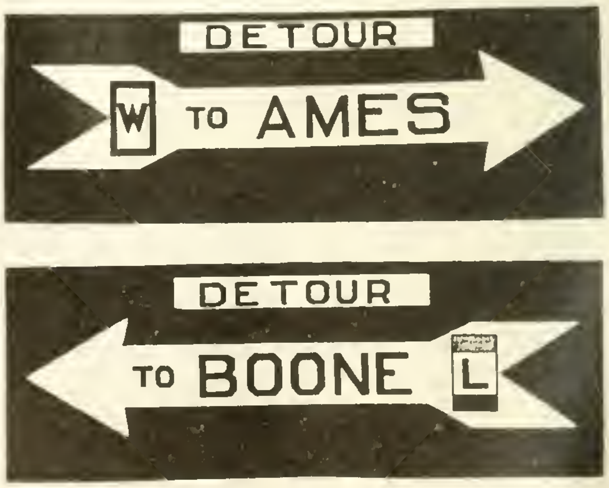


Fig. 2—Typical Detour Sign Showing Highway Symbol and Name of Town.

Primary Road Construction Detours.—When primary road construction is started, the district engineer becomes responsible for the detours due to such construction. The Commission will hold each district engineer accountable for four items in connection with this work, as follows:

First—He shall determine whether or not a detour is needed.

Second—He shall co-operate with the local officials in choosing the location of the detour.

Third—He shall provide for the proper marking of the detour.

Fourth—He shall provide for the maintenance of the detour and report such provision to the central office.

Determination of Necessity.—In deciding whether or not a detour is necessary, the district engineer should be guided by the fact that both the public and the contractor are greatly inconvenienced when an attempt is made to carry traffic over construction work. If a [illegible] road is at all available it is nearly always desirable to divert the public away from the construction work, even though the road has not been entirely blocked by the work. Where paving is being constructed, it is self-evident that the road must be closed and detours provided. People living along the highway which is closed must be allowed to get in and out along the road but this is another problem and should be handled by the resident engineer. Rural mail carriers should temporarily change their routes rather than try to travel a closed road.

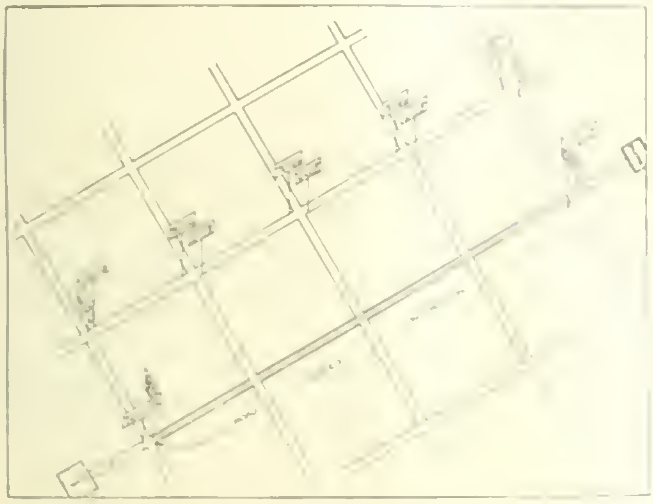


Fig. 3—Typical Arrangement of Detour Signs.

Choice of Detours.—After it has been determined that a detour should be selected, the district engineer should confer with the board of supervisors and county engineer and choose a route which will best serve the traveling public. The district engineer should be mindful that the detour will be forced to carry a much heavier traffic than it has in the past. Care should be taken to select as good roads as possible for the detour. The public would rather detour two or three extra miles over a good road than save that mileage by traveling over a poor one. It is ordinarily better to detour over a county road than over a township road. In some cases in order to divide heavy traffic, it may be advisable to select two detours, one to carry the traffic in one direction and the other to carry it in the opposite direction.

Making Detours.—Great care should be used in placing the detour signs. The sign should be so placed that anyone no matter how unfamiliar he may be with the location of the roads will be enabled to follow the detour around the obstruction without delay or confusion. No road should be closed until all detour signs have been placed. As the traffic will use the detour in both directions, the detour signs should be placed accordingly. (This does not hold true if two detours are used, as in this case it is usually best to direct the traffic in opposite directions over the different detours.)

Figure 3 shows a typical arrangement of signs. The signs should always be placed at the right hand side of the road at the far side of the intersection. The arrow will then point away from the intersection and will give a positive direction. If suitable telephone poles or fence posts are not available in proper locations upon which to nail the signs, posts should be set for this purpose. As the signs are to be used only for a short time, a good 4x4 serves satisfactorily. The first detour sign should be placed squarely in the middle of the road in front of the barricade. A "Road Closed" sign should not be featured near this sign as many will interpret it to mean that the detour is closed. The barricade crossing the road should be substantial and should extend from shoulder to shoulder. It should always be placed at the intersection where the detour leaves the main road. These posts set [illegible] in the ground [illegible] for a 2x12 [illegible] which may be nailed to them. [illegible] In order to slow traffic down [illegible] of the presence of a barricade, especially at night when the red lights may have gone out, it is desirable to place a "Slow Down" sign about 400 ft. back from the intersection. This sign should be placed close to the shoulder line on the right hand side of the road and should read "Slow Down—Road Closed." It should be rather flimsy in construction so that in case it is hit by a passing car no serious damage will be done.

Maintenance of Detours.—The maintenance of detours around primary road construction is to be administered and paid for the same as the maintenance of primary roads. The detour while used as a primary road will be considered as a primary road for the purpose of maintenance no matter whether it be a county or township road. At the time the detour is laid out arrangements for its maintenance should be made by the district engineer and local officials. The district engineer should report to the central office, first, the exact location of the detour; second, its length; and third, the provisions made for its maintenance. The maintenance of the detour should include the maintenance of the detour signs and such maintenance will be included in the responsibilities of the District Engineer. The County Engineer should charge the maintenance bills for each detour to such detour and should report them as separate items.

Detours on County Work.—In the case of detours around any bridge or culvert work regardless of the road system upon which such work is being done, or in the case of detours around county road construction or maintenance work, the same general principle holds true, as above described, except that the county engineer is the responsible party instead of the district engineer. In a bridge and culvert construction it is better to mark and maintain a detour. Detour made necessary by county construction or maintenance work should be maintained out of county funds. Each county engineer should keep a supply of detour signs on hand so that they will be available on short notice for use in emergencies.

Value of Subgrade Drainage for Pavements.—An excellent example of the value of subgrade drainage was cited by Mr. Carl F. Meyers in a paper, "Observations on Concrete Pavements" presented Feb. 19 at the 27th annual convention of the Minnesota Surveyors and Engineers' Society. A street was paved with two strips of pavement 16 ft. wide, separated by a 22 ft. park strip. At one point on the street a cut 10 to 12 ft. deep was made into a hill where the soil was heavy clay. A considerable number of springs and spongy places were encountered. A strip of pavement was laid along one side of the street in the fall of the year. Drainage was had through a line of tile at each edge of the paved strip. During the succeeding winter this stretch of pavement heaved badly with rises of 3 and 4 in. over parts of some slabs. In the spring the slabs returned nearly to their previous position, but badly cracked. The paving of the other strip was then proceeded with, but through this cut, diagonal lines of tile were laid under the pavement at about 30-ft. intervals draining into the side line tile. The succeeding winter showed the same heaving on the first strip laid as observed the previous winter, but no heaving on the second strip was noted. Since those seasons this difference in behavior in the two sides can be observed. There is also very little cracking of slabs on the diagonally tiled strip.

No Retained Percentages on Indiana Highway Work.—Highway contractors in the State of Indiana, according to the June 26 Bulletin of the Associated General Contractors, have secured the consent of the State Highway Commission to advance to contractors engaged in building state highways, 100 per cent of the contract price per mile upon completion of each mile of road. Settlement on this basis will not be final, but will be subject to adjustment up till the time the whole is completed. The proportion advanced on each completed mile heretofore has been limited to 80 per cent. Conferences held at Indianapolis between the highway contractors and the state highway commissioner during June, led to the adoption of the plan. The new arrangement must be approved by the State Board of Accounts before it can be put into effect.

Percentage Contracts for Highway Construction

[illegible] contracts for [illegible]. The State [illegible] Commission [illegible] percentage type of contract [illegible].

[illegible] by the department [illegible] the same [illegible] to inspection [illegible] estimate the contractor [illegible] 10 per cent for the work. [illegible] whether the cost of the work is [illegible]. In addition to this 10 per cent [illegible] rented at standard rates [illegible] with the work are paid direct from the Highway Department's office. The work is at all times [illegible] control of the engineer.

The Virginia Profit and Loss Sharing Plans. The State [illegible] Department of Virginia has tried a "profit or loss" [illegible] on two contracts. It was found, however, that this system had a great many difficulties, and the department [illegible] is not considering trying it on other contracts. The [illegible] was made a part of the regular [illegible] contract and was carried as a rider. The contractor [illegible] to give the usual form of bond. The cost of the [illegible] insurance, etc., was chargeable to the con[illegible] of the profit. The agreement follows:

PROFIT-OR-LOSS SHARING AGREEMENT.

[illegible] prices for all the quantities of [illegible] on the proposal. The cost of the work [illegible] and quantities will be herein referred [illegible] Contractor's Estimate.

[illegible] be paid actual cost for the labor and [illegible] the execution of the work provided to be done [illegible] whether the cost be more or less than the [illegible]. The cost of work thus determined will [illegible] referred [illegible] the Labor and Material Cost.

3. [illegible] will be paid a fee of 10 per cent of the Con[illegible] for his actual supervision of the work, the [illegible] of all equipment, and all office and other [illegible] known as "Overhead Expenses," except that [illegible] Labor and Material Cost be less than the Contractor's [illegible] Contractor's fee will be increased by the amount [illegible] or should the Labor and Material Cost [illegible] the Contractor's Estimate the Contractor's fee [illegible] by the amount of one-half difference.

4. [illegible] necessary to increase or diminish the [illegible] shown on the proposal, the Con[illegible] be revised accordingly, at the unit prices [illegible] for Class B Concrete shall be [illegible] yard for additional concrete in the sub[illegible]. The Contractor's Estimate so changed shall be known [illegible] Estimate, and shall be compared [illegible] Material Cost in computing differences, in[illegible] Estimate as first determined.

[illegible] to be paid the Contractor for labor, teams, ma[illegible] of every kind and description, furnished [illegible] approval of the Engineer.

[illegible] and payrolls for all items [illegible] Material Cost. Bills shall be certified [illegible] Pay rolls shall be signed [illegible] the Contractor.

[illegible] of every kind and [illegible] shall [illegible] to the [illegible]

The Georgia Cost Plus Type of Contract. A new form of [illegible] has been prepared by W. R. [illegible] Engineer of Georgia for the work of [illegible]. The [illegible] reprinted below.

[illegible]

[illegible] day

[illegible] to

[illegible] and [illegible] of [illegible]ng

made a part of this contract and identified by the signature of the respective parties hereto, and

WHEREAS, The contractor undertakes to perform this work in accordance with the terms and conditions hereinafter stated:

NOW THEREFORE, The parties to this agreement, in consideration of the respective covenants and agreements herein contained, do hereby contract and agree as follows:

1. The Contractor shall act as agent for the owner in executing the work covered by this contract, in purchasing material therefor, and in employing labor to be used in the construction thereof, in accordance with the aforesaid plans and specifications hereto attached, marked Exhibit "A" and made a part of this contract.

2. The Owner agrees that said work shall be done by the contractor under the sole supervision of the State Highway Engineer, or his authorized representative acting as an engineer for the Owner, without interference from the Owner. The Owner further agrees to pay promptly, upon approval of the Engineer, all bills for labor, transportation, and material as further provided in paragraph 5 of this contract.

(a) The Engineer shall determine the true intent and meaning of the plans and specifications, and shall adjust all questions of extra compensation for extra work arising or required during construction. Said Engineer shall have the authority to inspect and pass upon all materials purchased, shall prescribe the results to be obtained under the specifications, and shall direct the progress of the work, holding the contractor strictly accountable for the results to be obtained as set forth in detail in said specifications.

(b) Said engineer shall have the right to make any necessary changes in the plans and specifications, provided that such changes are agreed upon in writing, signed by all the parties thereto, and attached to and become a part of this contract. No such change or alteration shall operate to invalidate this contract or defeat the true intent or meaning of the agreement as a whole. No such changed plans shall be made without said agreement having first been executed, signed by all parties hereto, attached to and made a part of this contract.

3. (a) In consideration of the faithful performance of the covenants and agreements made hereunder by the contractor, the owner hereby covenants and agrees to pay, or cause to be paid to the contractor the following fixed sum as compensation for his services, and under the following terms of payment, to-wit:

....

....

(b) The compensation above stated shall cover all services rendered by the contractor, or by his organization, whereby the owner receives the benefit of the contractor's business system, purchasing facilities, engineering skill and experience, and ability to equip, to organize with skilled foremen and laborers, to supervise and execute work of this nature. It shall include all other services necessary to the efficient execution of the work not specifically included under paragraph four hereof. The contractor agrees to maintain a competent representation at all times in immediate charge and supervision of this work as a part of said services without extra cost to the owner, which supervision shall be included in and form a part of the contractor's fixed sum compensation.

(c) The contractor shall be paid, monthly during the progress of the work, a portion of his "Fixed Compensation" in the ratio that the work then completed bears to the value of the whole work; provided, that at one time until the final completion and acceptance of the work, the total amount of said monthly payments on account of the "Fixed Compensation" shall exceed fifty per cent (50%) of the total "Fixed Compensation."

(d) The contractor further agrees to prepare and submit an itemized list of all equipment, machinery and tools of every nature whatsoever which he intends and expects to use on the work, and he shall specify a rental price at which each item of said equipment and tools shall be furnished. Said list and the prices affixed thereto shall be attached to and form a part of this contract. Said rental price shall be made on the basis of the calendar month or fraction thereof. All equipment and tools furnished by the contractor must be in good condition, and shall be subject at all times to the inspection and approval of the State Highway Engineer or his authorized representatives, who shall also have the authority to release any part of said equipment, or tools from the work at any time he may deem it unsuitable or unnecessary for the work, and upon the written release of any particular portion of equipment or tools, signed by the State Highway Engineer or his authorized representative, being presented to the contractor, the rental upon said machinery or tools shall cease. Any omissions or changes from said list of equipment at the time of signing this agreement through error, oversight or unforeseen circumstances, shall be the subject of an amendment hereto as set forth in paragraph 2b hereof.

4. The contractor agrees to prepare and submit an estimate of the cost of the work as contemplated by the aforesaid plans and specifications based upon unit costs and approximate quantities as set forth in the proposals, together with a detailed and itemized analysis of all the factors and conditions entering into said unit costs, all of which are to be attached to and are hereby made part of this contract as fully and to the same effect as if the same had been set forth at length in the body of this agree-

ment amounting to approximately [illegible] Dollars ($)

The consolidated estimate arising from the above proposals shall be known as the "Cost of Work" and shall include all items of rental, field repairs to equipment, transportation of materials, cost of materials and of labor, including timekeeper or accountant, but not including the services of the construction superintendent, which shall be covered as provided in paragraph 3-b hereof.

It is thoroughly understood and agreed that the quantities herein quoted are approximate only, and are given for the purpose of calculating the cost of the work and are not the final quantities upon which final payment is to be made.

Any changes in quantities arising during construction, whether increases or decreases, shall be computed and certified by the State Highway Engineer at the unit prices quoted herein.

5. The owner agrees during the construction to pay for all material, labor and transportation included under the cost of the work purchased by the contractor acting as purchasing agent or furnished by him upon proper bills of particulars and payrolls approved by the State Highway Engineer or his representative, in amounts as shown by the said bills and pay rolls, payment to be made by the owner on statements approved by the State Highway Engineer.

(a) The owner shall furnish funds sufficient to take advantage of any or all trade or cash discounts, that may be afforded by the contractor's purchasing facilities, and said owner shall pay such bills and secure the entire benefits of such discounts upon the approval of the Engineer.

6. It is agreed that, if on completion of the work the actual cost shall be less than the estimate of "Cost of Work" as set forth under paragraph 4 hereof the owner will pay to the contractor 25 per cent of the difference between said actual cost and the estimated cost, provided, however, that said payment shall in no event exceed 50 per cent of the contractor's fee hereinbefore specified.

(a) If, however, the actual cost, exclusive of any changes in specifications or extra quantities, shall exceed the cost of the work as set forth under paragraph 4, the owner shall deduct from the compensation due the contractor, as set forth under paragraph 3, fifty (50%) per cent of said excess cost, provided the owner shall have permitted the contractor to buy all materials and secure labor in the open market without constraint from the owner, and provided further that such deduction shall not exceed seventy-five (75%) per cent of the contractor's compensation.

(b) For use in comparing bids, the estimated "Cost of Work," "Rental" and "Fixed Compensation" as figured herein as given as follows:

"Cost of Work" .... $
"Rental" ....
"Fixed Compensation" ....

Grand total .... $

7. Whenever, the contractor accepts material or labor furnished by the owner at specified prices for use upon this work without having first, in writing duly served upon the owner and upon the State Highway Engineer, objection to such material or such labor, specifying his objections thereto, he shall thereafter be estopped from pleading constraint in the premises, the conclusive presumption being that the prices accepted were the most favorable which the contractor could obtain in the open market when the acceptance was executed. However, having served such notice and bill of objections in writing, and in the event of his being required by the Engineer to use such material, the contractor thereby accepts no responsibility for the result of its use, but this responsibility shall not be released in connection with any part of the work except that wherein the particular material entered.

8. The construction work and the labor provided for in this contract shall be done under the direct supervision of the State Highway Department of Georgia, and in accordance with the laws of the State of Georgia, and in case of Federal Aid Work, subject to the inspection and approval of the Secretary of Agriculture of the United States or his authorized agent, and the rules and regulations of the said Secretary of Agriculture made pursuant to the provisions of the Federal Aid Road Act of July 11, 1916 (39 Stat. 355).

9. Failure of the contractor to prosecute the work with diligence and skill, to supply sufficiency of material of the kind required by the plans and specifications, or to furnish sufficient competent workmen, and sufficient equipment and transportation as called for by this contract, shall constitute an abrogation hereof, and shall authorize the Engineer after ten days written notice to the contractor, to terminate this contract and to enter upon the premises and take possession, for the purpose of completing the work, of all materials and supplies and to use the same for the purpose of completing this contract.

10. The contractor agrees to take out and maintain at all times during the course of said work, at the cost of the owner, liability insurance in amounts to be approved by the State Highway Engineer to protect the owner and contractor from loss by reason of damage or injury [illegible] engaged on the work.

11. The contractor shall furnish to the owner a bond in the sum of $ [illegible] conditioned on the faithful performance of all of the conditions of this contract.

12. The contract shall be binding on the successors and assigns of the respective parties hereto, but no assignment shall be made or any sub-contract entered into by the contractor without the written consent of the owner.

13. The owner shall furnish the contractor such permits as may be required for the prosecution of the work.

14. The contractor further agrees to commence work within days from the date of notice of the award and to complete the work within working days.

IN WITNESS WHEREOF the parties hereto have set their hands and affixed their seals on the day and year first above written.

(Seal)

By

(Seal)

By

Signed, sealed and delivered in the presence of

Approved this the day of 19

State Highway Engineer

Cost of Highway Maintenance in Maine by Patrol System

Maintenance work on the highways in Maine during 1919 was performed generally by the patrol system, a method which has been in use in that state for the past 3 years. A total of 478 patrolmen were employed in caring for 4,284.52 miles of roads in 475 towns. Of this mileage 668.60 miles was improved state highway, 843.72 miles improved state aid highway and the balance or 2,772.20 miles was unimproved road. There was also maintained by special arrangement with the towns, 74.12 miles of improved state aid road.

According to the report of the State Highway Commission a total expenditure for labor and material of $653,452 was made on this work, including $18,354.31 furnished by the state for road machine work. The state also furnished supervision and inspection for the work amounting to $25,156, making the total gross expenditure chargeable to maintenance of $678,608.93. Of this amount the state furnished $471,376 and the cities and towns furnished $207,232. The average expenditure per mile was $155.69.

On the 668.60 miles of improved state highway, the expenditure for labor and material and supervision was $275,666 or an average expenditure per mile of $412.30. The expenditure on the 3,615.92 miles of other road under patrol was for labor, material and supervision $382,445.21 or an average expenditure per mile of $105.77.

Republic of Panama to Spend $7,500,000 for New Roads.—American construction companies, according to a press dispatch of June 27, are to be asked to undertake the work of building new public highways involving the expenditure of approximately $7,500,000 in the Republic of Panama. J. E. Lefevre, charge d'affaires of the Panama legation at Washington, D. C., has received instructions by cable to get in touch with the larger construction concerns in the United States, and ask them to send representatives to Panama to discuss plans for the road-building program, which is to be inaugurated in the immediate future. It is estimated that the program worked out by Panama officials involves an annual expenditure of $1,000,000 and the sum of $1,250,000 will be available to begin the work after July 1 of this year. Four or five years will be required to complete the work mapped out.

Delaware to Construct 40 Miles of Asphalt Surface on Bituminous Base. The Delaware State Highway Department is completing plans for about 40 miles of bituminous foundation and asphalt wearing surface. Proposals will be called some time about the middle of August. A smaller section, consisting of approximately 15 miles of asphalt surface road, was tried out in Sussex County, Delaware, and the result proved very gratifying to the users of these highways.

Massachusetts' Experiences in the Treatment of Sand or Gravel Roads With Bituminous Materials*

By WILLIAM D. SOHIER

[illegible] State Highway Commission, Massachusetts

We have in Massachusetts quite a large section of territory [illegible] of a sandy nature. This is particularly true on Cape Cod, and in this section of the state broken stone or gravel has to be transported 150 miles more on the railroad, and a two horse team can only haul about ¾ ton over the sand, making the cost of building roads with those materials practically prohibitive. It became almost imperative, therefore, that we should find some method of constructing roads with the local material, sand, using something else in combination with it that would not be too expensive.

Naturally, the first materials that were used were what was available locally, either clay, if it could be found, and if not, loam mixed with the sand or spread on top of it in order to harden it sufficiently so that it would not rut very badly. Roads built of these materials, if properly proportioned and kept constantly crowned and shaped, make extremely satisfactory roads for light traffic. We then began to look around for other materials that might be used which would make a better road at a reasonable expense.

The Earlier Sand-Oil Roads.—The first sand and oil roads were constructed by the Massachusetts Highway Commission on Cape Cod in the town of Eastham in 1905. When this road was first commenced, they followed the California method of constructing roads with asphaltic oil, which was to spread the oil on the ordinary soil, which had been broken up, in two or three layers of oil of ¾ gal. to the square yard each, and then after harrowing it, tamp it with a tamping roller which tamped the soil from the bottom up and also mixed the oil and earth together. To do this successfully required the use of a very large amount of water while the work was going on, nearly 12 gal. of water being used for each gallon of oil. In building these roads in California, they use in all about 2 gal. of asphaltic oil to a square yard of surface.

We very soon found, however, that on the sand this method was not successful and that it was better to spread the oil in layers in what might be called a blanket coat of ¾ gal. to the square yard, covering that with sand, then spreading another similar coat of oil and covering that with sand, and then a top surface of oil, about ½ gal. to the square yard.

In 1907 we tried in several places in the state a number of experimental sections of road by the mixing methods, using various grades of tars and various qualities of asphaltic oil and residual oils mixed with asphalt, these bitumens being heated and mixed with the heated sand or gravel, and then spread upon the road surfaces and shaped and rolled.

Methods of Constructing Sand-Oil Roads.—In constructing either of these roads, you must first carefully prepare your subgrade. On Cape Cod sand this means that you must harden the subgrade by using clay or loam, so that when the wagons distributing the oil go over it they will not rut it up very much, nor will the horses' feet cut into it materially. In the first roads that we built, though they were successful in the end, they certainly looked hopeless in the beginning, because of the deep ruts which were formed by the oil-distributing wagons and the deep holes in the sand that were made by the feet of the heavy horses. The oil naturally ran into these depressions and left very few drops on the rest of the surface [illegible] the result was [illegible] that we [illegible] where the oil ran [illegible] and pipe [illegible] onto a [illegible] distributed [illegible] better results.

[illegible] piled, [illegible] car [illegible] ches. [illegible] and formed, to give it a crown of about ¾ in. to the foot. Any weak places which then developed were patched with a mixture of sand and oil, and then a surface coat of about ½ gal. of oil to the square yard was applied, and this was covered with sand and kept constantly covered from time to time until no wet oil appeared upon the surface.

In constructing the roads by the layer method, we found the best results were secured by applying about ¾ gal. of oil on the sub-soil and covering this with about ½ in. of sand. On this we spread a second ¾ gal. of oil and a second coating of ½ in. of sand, and the first road that we built had to be broken up and reshaped as I have described. On the later ones, we merely had to shape the roads a little with the road machine and then apply ½ gal. of oil for the surface coat, and this was covered with about 1 in. of sand but had to be kept constantly covered if any wet oil appeared upon the surface. We secured, we thought, somewhat better results, especially if the work was done late in the year, if the road was let go through the winter with the first two coatings of oil, and then shaped and the final surface put on in the spring.

The oil that was used in this work was the same quality of asphaltic oil that was used for hot blanket surfaces, an oil that was supposed to contain about 90 per cent of asphalt and that had to be heated to about 250° F. in order to spread evenly.

A clean, sharp, fairly coarse sand will give the best results, but a comparatively fine sand, and even one containing a small proportion of clay or loam (not more than 5 per cent or 8 per cent), will give good results with a proper grade of oil.

In the layer road, you cannot use successfully the heavier grades of asphaltic oil, you must use an oil that will continue to mix with the sand during the summer weather. Tests made of the sand used on the work in various places show that the finest sand was such that 24 per cent passed the 50-mesh screen and only 4 per cent was retained on an 8-mesh screen, whereas the coarsest sand 12 per cent was retained on an 8-mesh screen and only 18 per cent passed the 50-mesh screen.

We very early found that if roads of this character were to be successful, they should be crowned about ½ in. to the foot, and they must be at least 18 ft. in width and were much better if they were 20 ft. wide, unless there was some material on the shoulder which would carry the traffic without rutting deeply. If a narrower width was used and teams kept constantly turning out, they very soon cut away the side of the road when they came back and narrowed it up, so that at the end of the season, where we built a road 15 ft. in width, there was only from 9 to 12 ft. of width left. We usually try now to bank the corners and make them 21 ft. in width.

Construction and Maintenance Costs.—The cost of the surface of these sand and oil roads constructed by the layer method varied from 21 ct. to 33 ct. per square yard, the average cost being about 26 ct. per square yard. This cost does not include grading, culvert work, etc., but does include shaping the sub-grade. The average yearly cost of maintenance of the first section constructed in Eastham 16 years ago has been 2 ct. per square yard per year, and of the other roads constructed during the last 11 years 1 ct. per square yard.

It must be always kept in mind that in all the figures I am giving in this paper I am speaking of prewar conditions and prices, when the asphaltic oil used cost about 6½ ct. a gallon on the cars, and when labor was $1.75 to $2 a day and double teams $4.50 to $5. For today's costs I think you would have to at least double the above figures.

Hot Mix Oil-Sand Roads.—As I stated before, we made a number of experimental sections, using gravel and sand, heated and mixed with hot oil, on a number of sections of road in 1908, but we built our first mile of road by this method in 1909. That road and some of the experimental sections are still on the ground and doing service, although they have been widened and in most instances have had a surface coat. Until 1912, this work was done by hand, the sand or gravel being heated on old boilers or iron sheets with a fire underneath, the oil being heated in a kettle and the two mixed together by hand or a mixing board.

Today we use a hot mixer, at any rate to mix the oil and sand, usually the type of cube concrete mixer operated by steam and equipped with a charging device and heating attachment which consists of an oil burner with an air-blast throwing the flame into and through the mixer. The portion of the mixer with which the flame comes in contact is lined with fire brick.

During the last few seasons, the sand, which was formerly heated on old boilers or arch [illegible], has been heated in a revolving drum heater with oil burners, which is very similar to that used in sheet asphalt work, and on the whole produces more uniform and better results on both sand and gravel roads than any other method. The heating drum has blades or flanges bolted onto the inside, which carry the sand or gravel to the top where it falls through the hot blast from the burners. The drum is inclined to carry the sand slowly to the lower end. It is revolved by either a steam or gasoline engine.

In our experimental sections the only ones that were successful so that they were in good condition at the end of the season, where sand was used, were two or three sections which were constructed of an asphaltic oil supposed to contain from 80 per cent to 90 per cent of asphalt or the same asphaltic oil made stiffer by the addition of 25 per cent of asphalt. The sections which were placed where lighter asphaltic oils were used, or tars, were none of them in good condition at the end of two seasons, and all of them had to be rebuilt.

Where gravel was used, there were a good many more sections that were in fairly good condition for two or three years, though the only really satisfactory and good ones were the ones where the heavy asphaltic oil has been used or the same oil enriched with asphalt. Some of these sections have carried pretty heavy traffic during the last 12 years.

General Construction Features of Hot Mix Oil-Sand Roads. In constructing these surfaces, whether of gravel or sand, you want a well-shaped, well rolled and hardened [illegible]. The sand and oil have to be heated to the proper temperature and mixed by hand or by machine. If by hand, the mixing is done on platforms with rakes and hoes, or by turning with shovels. The mixing must be continued until every grain of sand is coated with oil.

There are several rough-and-ready methods of determining this. One, when a proper mixture is made and the right quantity of oil is used, the product resulting will be somewhat of the consistency of old-fashioned brown sugar. It should look granular. It should tend to crawl and move for some time when heaped up if you rake it, but it should consolidate pretty well when compressed under the heel or in a cloth, but not enough to become wet or sticky. After it is spread upon the road and rolled, it still has a somewhat granular appearance at first, but this should very soon disappear when much traffic has gone over the road. It then consolidates and becomes watertight. Occasionally hair cracks occur at first, but they close up under traffic. Both of these remarks apply to gravel and oil, as well as sand and oil.

For this work, from 15 to 25 gal. of oil or oil asphalt have been used per cubic yard of loose sand, but ordinarily the best results have been obtained by the use of from 16 to 18 gal. per cubic yard of sand, if loose, or about 18 to 20 gal. if it is compacted.

The quantities of oil used are measured hot, when they expand about one-seventh of their volume when cold.

To obtain satisfactory results, sand must be dry as well as hot. Wet sand or gravel or stone cannot be mixed satisfactorily with either tar or asphalt. It produces a coating of steam which prevents the hot bitumen from adhering to the material.

If the sand in the pit when used is fairly dry, it can be mixed in a hot mixer without preliminary heating, but this is not economical, as from 5 to 6 minutes are then required to mix the batch thoroughly, whereas, with hot sand the mixing can be done in about 2 minutes. The oil, before mixing with the sand, is heated in kettles or tanks to temperature of from 250° F. to 375° F., depending on its density. The oil used for this work with either gravel or sand will vary from 65 to 70 penetration up to 120 penetration. In fact, very satisfactory results will be obtained with "Bermudez," which has a penetration of 120 to 145. The finer the sand, or the more rounded, the heavier the asphalt that must be used in order to make the mixture stiff. The same is true of gravel.

The sand or gravel oil mixture, after it has been mixed, is immediately carted to the road and spread, usually in one course, and shaped and immediately rolled. A horse-roller is used for the preliminary rolling, but the surface should be rolled with a tandem steam roller in the course of a few hours. The length of time which should elapse before using the tandem [illegible] temperature and general weather conditions. Ordinarily, any material placed in the morning may be rolled in the afternoon of the same day. Care must be taken not to allow the roller to stand or stop for any appreciable time on any of the hot mixture, or it will certainly produce a depression. It should be run back onto the cold material, or onto the hot grade, before it stops. [illegible] to have the roller run [illegible] that also produces a [illegible] surface. We roll diagonally, as well as lengthwise.

We have found that we obtain better results on sand and oil roads if we keep them constantly shaped with a road machine while we are rolling them with the horse roller, and fill all depressions and then put on a surface coat of ½ gal. per square yard and cover and keep this covered with sand, than we formerly did when we tried to lay the road all at one time. It is not advisable to use a steam roller on sand and oil roads for the preliminary rolling, as it tends to force the material out of shape and to produce an uneven and wavy surface.

I will add another warning, and that is that, when it is rather cold weather in the morning or afternoon, especially if the ground is cold, you must be careful to make sure that the middle of your mixture has cooled sufficiently not to squeeze out ahead of the roller. So do not be deceived because both the top and the bottom of the mixture have cooled. Before the tamping roller is used, the middle mixture should be cooled to 70° or 80° or thereabouts, or it has a tendency to squeeze out ahead. Under ordinary conditions, our best results have been obtained with an oil asphalt having a penetration of 90 to 125. If the grains of sand are rounded, especially if the sizes of the grains vary little, as with ordinary beach sand, a very heavy oil asphalt gives the best results, whereas with a sharp sand, well graded and containing a considerable proportion of grains, which will not pass a screen with a ⅛ in. mesh, a less heavy oil will produce good results, probably 90 to 110 penetration should be used.

After the sand and oil mixture has been thoroughly rolled, the surface is sealed by the application of a hot oil having from 80 per cent to 90 per cent of asphalt. This oil is spread by a pressure distributor in two ¼ gal. applications, each followed by a light covering of sand. This coat not only seals the surface of the mixed sand and oil, but also adds about ½ in. to its thickness. It should be constantly covered with sand from the beginning, and also on the first hot days if the work is done in cold weather, so that the surface is never picked up.

Mixed sand and oil surface should have a crown ¼ to ½ in. to the foot, should not be less than 18 ft. in width, and better be 20. The thickness should be from 3½ to 4 in. after rolling and before the seal coat is applied.

Best Results Obtained with Fairly Coarse Sharp Sand. Tests made with sand from different pits used for mixed sand and oil work in Massachusetts show that, with the finest sand used with good results, 51 per cent passed a 50-mesh and only 4 per cent was retained on an 8-mesh screen, whereas of the coarsest sand 35 per cent was retained on an 8-mesh and only 12 per cent passed a 50-mesh screen.

It is evident that a fairly coarse, sharp sand, the particles of which are well graded, gives the best results. It is also true that a comparatively fine sand, the grains of which are sharp and not all of one size, gives satisfactory results, although a heavier oil is required. The coarse sand will probably carry heavier loads and wear longer.

I hesitate to make my next remark, because it is of very limited application and must not be at all extended, and that is that a small amount of clay or loam (not over 5 per cent or 7 per cent) is not objectionable, but as any large percentage of these materials will practically ruin your work, their use should not be allowed, unless it is absolutely necessary or where the sand does not contain a sufficient amount of small grains to make the proper grading. Here vastly better results would be secured by the use of 5 per cent or 10 per cent of cement or even of fine stone dust, if either of these materials can be secured at a reasonable cost.

Mileage of Sand Oil Roads in Massachusetts.—We have in Massachusetts something over 17 miles of road that is still in reasonably good condition that was built of sand and oil by the layer method. We have about 8 miles more of the layer road, where the layer method has been used to widen [illegible] roads was about 27 ct. [illegible] of mixed sand and oil [illegible] in the [illegible]nal construc[illegible] resurfaced and [illegible] used on top of [illegible] miles of road in the [illegible] mixed

Construction and Maintenance Costs of Mixed Sand and Oil Surfaces.—[illegible] of mixed sand and oil surfaces, in[illegible] varied from 40 to [illegible] ct. per square [illegible] until 1919 when the lowest [illegible] was about $1 a square yard for the [illegible] for the surface alone, and does [illegible] culvert work, etc. The average [illegible] these roads, which have been in [illegible] about 2 ct. per square yard per year, [illegible] been in use [illegible] years, the average cost of [illegible] per square yard per year. The [illegible] the above figures except the $1 per [illegible] construction.

Gravel and Oil Mixed Roads.—I have included bituminous gravel in [illegible] remarks. Undoubtedly where gravel can be obtained [illegible] better results and stronger roads will result. We [illegible] a good many miles of road in Massachusetts of bituminous gravel and we think very well of them, even for a very great volume of traffic, including quite a number of heavy trucks. We have also resurfaced and widened a great many miles of road, 75 to 100 miles, where we used the [illegible] water-bound macadam road as a foundation, when there [illegible] 2 or 3 in. of it still left.

Where the traffic is heavy and we are building a bituminous gravel road, we have, of course, put in a foundation of [illegible] field stone where the sub-soil was not good. We have [illegible] usually put a crusher into the gravel pit and crushed the larger stone, and perhaps field stone as well, and have laid the foundation of broken stone about 4 in. thick, well shaped and thoroughly rolled. On this, we have spread the mixed gravel and oil, so that it would be about 2½ in. thick after rolling with the steam roller. Even with good [illegible] conditions, where the roads had heavy traffic, we have [illegible] either broken stone or gravel in the sub-base, so that when watered and thoroughly rolled by the steam roller, it would be 4 or 5 in. in thickness.

The [illegible] course or wearing surface is just a mixture of asphaltic [illegible] of from 90 to 120 penetration, thoroughly mixed with the heated gravel, and spread evenly so that it would be about 2½ in. thick after rolling. A tandem roller [illegible] the best for rolling this material, as it can be [illegible] better without producing depressions like a heavy steam roller. This mixture usually requires about from [illegible] 22 gal. of oil to the cubic yard of loose gravel, the [illegible] measured out.

These roads should be built at least 18 ft. in width, even with good material in the shoulders; with poor material, they [illegible] or 20 ft. in width to prevent having the [illegible]. A ¾ in. crown to the foot is better than a ½ [illegible] a practice of banking all of our corners [illegible] that is physically possible and giving them [illegible] to the inside of ½ to ¾ in. to the foot of [illegible]. When we first began the work, we used California [illegible] with good results, and since then we have used Texas [illegible] and other asphaltic oils with very good re[illegible]

[illegible] roads cost no more, and usually a little less [illegible] and they were much more [illegible] automobile traffic and [illegible]

[illegible] ct. per square yard including [illegible] but not including grad[illegible] the cost for the sur[illegible] per square yard material, [illegible]

Traffic Carried by Sand-Oil Roads.—[illegible] predict [illegible] They [illegible] condition on [illegible] horse [illegible] They [illegible] damage [illegible] would [illegible]

[illegible] mixed roads [illegible] been [illegible] gravel [illegible] rily for 6 to 8 years with much heavier traffic than this, especially in trucks. I have in mind one section in particular that was constructed and opened up to traffic leading directly to Camp Devens, where they had a cantonment for about 30,000 soldiers, built during the war. It had some days as many as 700 trucks going to that cantonment, and when they built a very large hospital there, they moved from 30 to 40 lumber trucks, weighing 12 to 13 tons, including the load, over that road every day. This made a very heavy traffic indeed for the two years that that road has been built. I think I am safe in saying that that road has never shown any signs of weakness or needed any patching whatever.

Substantial and Attractive Type of Wooden Guard Rail Used on Oregon Roads

A wooden type of guard rail developed by Multnomah County, Oregon, has been adopted by the Bureau of Public Roads for Western Federal Aid roads. This type was first used on the Columbia River Highway in places where a particularly substantial and artistic design was desired, and one that would be less expensive than the stone fence constructed along parts of the highway.

The posts, spaced 8 ft. c. to c., consist of 8-in. by 8-in. timbers, surfaced on four sides, and stand 4 ft. 3 in. above the ground. Normally they are set 3 ft. 9 in. into the ground, but are carried to greater depth as required by local conditions. To protect them from moisture they are painted with an approved bituminous paint for a length of 1½ ft. from their lower ends.

The two rails, consisting of 3-in. by 8-in. timbers, also surfaced on four sides, are spiked or drift-bolted to the posts, and great care is observed, by drilling for bolts and even for spikes, if necessary, to prevent the splitting of the rails. They are cut to the length necessary to span two panels of the fence, and are squarely butt-jointed at the posts, the two rails breaking joints.

Before erection all contact surfaces and the tops of the posts are treated with one heavy coat of a white paint, consisting of white lead and zinc oxide in the proportions of 3 to 1 by weight, mixed with raw linseed oil and turpentine drier.

After erection the entire exposed surface of the fence is given three coats of the same white paint. As it has been found that the bituminous paint used as a preservative has a tendency to turn the white paint yellow, it has become customary to paint a black band around the posts for a distance of about 9 in. above the ground, or high enough to cover the part of the bitumen-treated section of the post which is above ground. As each post is thus painted to the same height above the ground, the contrasting color really adds to the appearance of the fence.

Bid prices for the construction of the fencing of this type on the Columbia River Highway projects ranged from 60 ct. to $1 per lineal foot. The estimated cost per 8-ft. panel, according to a recent issue of Public Roads, is tabulated as follows:

75 feet b. m. lumber, at $40	$3.00
Setting and framing 1 post	1.00
Paint, 3 coats	.60
Bituminous preservatives per post	.20
	$4.80
Plus 20 per cent profit	.96
Estimated cost	$5.76

Cost of Grading Earth Roads.—Jackson County, Kansas, has been operating two county-owned grading outfits for the past two seasons. One of them consists of a 5-ton truck and 10-ft. grader and is used for heavy work, filling ditches and cutting side banks, widening the grades on dirt roads, etc. This outfit uses about 3½ gal. of gasoline, and 1 quart of lubricant per hour. Truck driver and grader man are each paid 60 ct. per hour of operation.

The other outfit consists of an 18-36 tractor and an 8-ft. grader. This is used for lighter work and shorter stretches where there is considerable turning. The 18-36 uses about an average of 2¾ gal. of gasoline and 1½ pints of lubricating oil per hour. The tractor driver and grader operator are paid a straight salary of $100 per month.

Mr. P. W. Wright, County Engineer, advises that they can do a first-class job of grading at a cost of about $18 per mile, including repairs, etc., but not including depreciation of machinery or interest on investment.

Comparison of Salaries of Engineers As Proposed by Engineering Council Committee and Congressional Joint Commission

On March 12, 1920, the Congressional Joint Commission on Reclassification of Salaries presented its report to Congress. Ever since this report was made public, [illegible] concerning it has been rife, and some [illegible] about the recommendations regarding salary [illegible] and employment policies has gained currency. [illegible] to clear up these misunderstandings and [illegible] to present an analysis of the Commission's report, the Engineering Council Committee on Classification and Compensation of Engineers has prepared a comparison of the two reports.

The essential features of the Joint Commission's report are incorporated in Table I which shows the salary range for the various grades of service as compared with that suggested by Engineering Council. The table also shows how the average salary as proposed by the Joint Commission, compares with the average salary received by employes in 16 engineering bureaus in civil establishments of the Federal Government on July 1, 1919.

TABLE I—COMPARISON OF CLASSIFICATION AND COMPENSATION OF ENGINEERS AS SUGGESTED BY ENGINEERING COUNCIL COMMITTEE AND BY CONGRESSIONAL JOINT COMMISSION AND OF AVERAGE SALARY PER ANNUM AS SUGGESTED BY CONGRESSIONAL JOINT COMMISSION AND PRESENT AVERAGE SALARY OF EMPLOYES IN 16 ENGINEERING BUREAUS IN CIVIL ESTABLISHMENTS OF THE FEDERAL SERVICE.

Engineering Council						Congressional Joint Commission								
										Annual salary range				
Grade	Title	Educational equivalent	Minimum experience, years	Minimum	Maximum	[illegible]	Title	Educational equivalent	Minimum experience, years	Minimum	Maximum	Estimated average	[illegible]	[illegible]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
8	(a) Junior aid office	High school	[illegible]	$1,080	$1,[illegible]	[illegible]	Copyist draftsman	High school	0	$840	$1,260	$980	$1,215	[illegible]
	(b) Junior aid field	High school	[illegible]	1,080	1,[illegible]	[illegible]	Junior engineering aid	Com. school	0	840	1,260	980	1,215	−19
7	(a) Aid office	High school	2	1,6[illegible]	2,[illegible]	[illegible]	Draftsman	High school	2	1,200	1,800	1,400	1,[illegible]	−[illegible]
	(b) Aid field	High school	2	1,680	2,[illegible]	[illegible]	Aid	High school	2	1,[illegible]	1,[illegible]	1,[illegible]	1,[illegible]	−[illegible]
	(a) Senior aid office	High school	[illegible]	2,520	[illegible]	[illegible]	No corresponding grade							
6	(b) Senior aid field	High school	[illegible]	2,520	[illegible]	[illegible]	No corresponding grade							
5	Junior assistant engineer	Degree	[illegible]	1,620	[illegible]	[illegible]	Junior engineer	Degree	0	[illegible]	2,160	[illegible]	1,[illegible]	[illegible]
4	Assistant engineer	Degree	2	2,700	4,140	[illegible]	Assistant engineer	Degree	2	2,100	[illegible]	2,600	2,[illegible]	[illegible] 8
3	Senior assistant engineer	Degree	5-1*	[illegible]	[illegible]	[illegible]	Associate engineer	Degree	[illegible]-1*	[illegible]	3,840	[illegible]	[illegible],128	[illegible]10
2	Engineer	Degree	8-3*	[illegible]			Engineer	Degree	8-4*	4,140	5,040	[illegible]	[illegible],501	[illegible]17
							Senior engineer	Degree	12-8*				[illegible]	
1	Chief engineer	Degree	12-7*	[illegible]			Commissioner, director, chief engineer or superintendent	Degree	[illegible]-*				[illegible]	

Notes.

Columns 4 and 10—*Years in responsible charge of work.

Column 13—Estimated average salary is the minimum plus [illegible] the difference between the minimum and the maximum. This [illegible] has been found to hold approximately for positions in the Federal [illegible] and was assumed in the studies conducted in connection with the [illegible] of the Reclassification Commission.

Column 14—Present average yearly salary, including bonus, [illegible] employes in 16 bureaus in civil establishments of the Federal Government. [illegible] bonus [illegible] $240 for salaries of $2,500 and under; for salaries above $2,500 it is the amount, if any, necessary to make a total of $2,[illegible].

Column 15—Average percentage increase (+) or decrease (−) [illegible] pay per employe under schedule proposed by Congressional Joint Commission over present schedule if distribution of employes within each grade remains unchanged. The estimated increase in the salary roll which would be caused by putting the Commission's [illegible] for all branches of the civil service into effect is as estimated by the Commission, 8 to 10%, probably 8.[illegible]

There have been certain increases since that date, particularly in positions carried on Lump Sum appropriations. It is probable, therefore, that averages at the present time would be slightly higher than those shown in Column 14 of the table, particularly in the lower grades.

The research staff of the Commission made estimates of the average salaries in the different classes for the Engineering service which are somewhat different than the figures of Column 14. They are slightly higher in the lower grades and slightly lower in the higher grades. These differences are brought about as follows: The Commission's averages are for the Washington service only. The averages in Column 14 include both the Washington and the field services. The Commission's figures included salaries paid in civilian positions in the War and Navy Departments. The Navy Department schedule is considerably higher than that of the civil bureaus and therefore the Commission's averages would be somewhat higher on this account alone. Finally, the averages will vary according to the classification of positions. It is believed that the Commission classified positions more liberally than Engineering Council's Committee. The Commission probably included more positions in the higher grades than did Council's Committee with the result that the averages for these grades are lower in the Commission's than in Council's calculations.

Since the Commission in any comparison of proposed with existing [illegible] it is evident that the averages will not be [illegible]. There appears no doubt, however, that in the upper two grades the averages proposed are less than the averages [illegible] with the bonus but how much less will depend upon [illegible] positions are classed within these grades and also data [illegible] for determining the averages.

In the Professional Group the Joint Commission recommends the same educational and experience [illegible] for Grades 5, 4, and 3 as Engineering Council but it recommends 4 years "in the direction or performance of important engineering work" for Grade 2 and 8 years for Grade 1, against Engineering Council's recommendation of [illegible] years and 5 years respectively. The Joint Commission provides for a minimum increase in salary from $1,800 for Grade [illegible] to $4,140 for Grade 2, i. e., $2,340, or 130 per cent in a minimum of 8 years. Engineering Council provides for a minimum increase for the same grades and number of years from $1,620 to $5,940, i. e., $4,320, or 267 per cent, more than double the rate of increase recommended by the Joint Commission.

The increments of increase proposed for the various grades are as follows:

Grade 8 $ 60—7 steps to maximum
Grade 7 120—[illegible] steps to maximum
Grade [illegible] 120—[illegible] steps to maximum
Grade 4 120—5 steps to maximum
Grade 3 120—5 steps to maximum
Grade 2 180—7 steps to maximum
Grade 1

The Joint Commission report states:

"The guiding factor as to the number of steps was the consideration as to whether the position was a stepping stone to a higher one or was likely to become the life work of an employe. In the later case more steps are provided than in the former.

"The minimum named is to be looked upon as the entrance salary of a class, i. e., new apointees are always to receive the minimum salary. This also holds with promotion into another class. The maximum salary is to be the absolute limit of compensation to which an employe can attain while in a given class."

In considering the determination of a wage policy the commission directed its attention particularly to three questions: (1) the minimum living wage; (2) the feasibility of periodic wage adjustments on the basis of the changing purchasing power of the dollar, and (3), the effect of reclassification on the lump sum and statutory methods of appropriation.

Texas Street Improvement Law Constitutional. The Supreme Court of Texas on June 23 handed down an opinion declaring constitutional the act of 1909 to authorize cities, towns and villages to construct permanent street improvements and to assess part of the cost against abutting property and owners thereof, and to provide for enforcement and collection of such assessments.

Consistency of Bituminous Materials for Highway Work*

[illegible] OST HUBBARD

[illegible]

[illegible] in highway engineering the term "consistency" is most commonly used to [illegible] of Webster's [illegible] consistency. Such terms are very [illegible] physical properties actually determined by the [illegible] tests for consistency, so broad in fact that results obtained by one method can not be accurately compared with the results obtained by any other method.

Before considering these methods and their significance, it should first of all be realized that the true bitumen of bituminous highway materials is in reality a fluid, although it is called semi-solid or solid when its degree of firmness passes certain arbitrary points. The one certain property of any fluid is that under certain conditions it will flow. Degree of firmness is therefore indicated by degree of fluidity, most readily determined by "resistance to flow," which is the accepted definition of the term viscosiy. Most of the [illegible] tests for determining the consistency of bituminous materials are therefore viscosity tests, although they may be made in a variety of ways.

The resistance to flow of any bituminous material is substantially influenced by the temperature of the material, a general rule being that the higher its temperature the lower becomes its resistance to flow. While this is true, the relative decrease in resistance to flow with increase in temperature is not necessarily the same for all bitumens and in fact may be widely different for different classes or types of bitumens which may show identically the same resistance to flow at a given temperature. Put in other words, some bituminous materials are more susceptible to temperature changes than others, and in general their consistency at a given temperature is no certain indication of their consistency at another temperature.

Bituminous materials may contain other material than bitumen and almost invariably, as used in highway treatment and construction, are purposely mixed or become mixed with mineral matter. The amount, character, and fineness or grading of the mineral matter may exert a tremendous influence upon the consistency of the mixture, and if the mineral particles are in sufficient quantity to be in contact their state of compaction is also an important factor. In the ultimate analysis, degree of firmness of such mixtures as they exist in the highway is the primary consideration, and selection or control of the consistency of the bitumen present is only one of a number of contributing factors in obtaining the desired degree of firmness, more often expressed as resistance to displacement of the mixture. If this reasoning is correct it is manifestly irrational to limit the consistency of a bituminous material with any greater degree of refinement than the control of other equally important factors bearing upon the resistance to displacement of the bituminous mixture.

Methods of Determining Consistency of Bituminous Materials.—Coming now to the methods determining the consistency of bituminous materials, we have first to consider the grade and type of material. So far as method of use is concerned, it is convenient to establish three general classes: (1) Materials for cold surface treatment, (2) materials for hot-surface treatment, and (3) materials for construction. The types are (1) petroleum and asphalt products and (2) tar products.

The consistency of both types for cold surface treatment is most frequently [illegible] and specified by a viscosity test [illegible] viscosimeter, which is used to [illegible] quantity of the material [illegible] standard tubular opening under a [illegible] the first consideration [illegible] that under ordinary atmospheric [illegible] uniform distribution over [illegible] accord[illegible] a maximum [illegible] to be [illegible] limit is [illegible] mixture with dust particles does not have to be taken into account. Petroleum products are used almost exclusively as dust palliatives, and should be sufficiently fluid to apply by means of a gravity distributor if necessary. A maximum specific viscosity of 10 at 25° C. will insure the desired degree of fluidity, and this is the only consistency requirement which is necessary.

When a bituminous material is to be applied cold for the purpose of building up a thin mat or carpet with a cover of mineral matter the ultimate stability of such a mat becomes an important quality. With the average mineral cover of broken stone or sand no cold application material possesses the desired degree of firmness, but it should approach this characteristic as closely as possible and should develop it to the fullest extent soon after application. As in the case of dust palliatives, a maximum viscosity limit is necessary to insure that it is sufficiently fluid to be applied at normal atmospheric temperatures. When application is made by means of a pressure distributor it has been found that a maximum specific viscosity of 120 at 25° C. is about the safe limit to use in the case of oil products, and a range of from 80 to 120 specific viscosity is considered reasonable. Cut-back asphalts, which harden rapidly through loss of a relatively small amount of volatile flux, may properly be held to a very much lower range, and for this class of material the American Society for Municipal Improvements has adopted limits of from 25 to 35 specific viscosity at 25° C. The reason for this is that allowance must be made for possible hardening during handling before application is made. Thus, if a maximum of 120 specific viscosity was allowed for cut back asphalts, unavoidable loss of volatile constituents before application might increase the consistency of the product to such an extent that it could not be successfully applied cold.

Viscosity of Tar Products.—Tar products for cold surface treatment are seldom used for the purpose of dust laying only. For mat or carpet construction it has become customary to specify their specific viscosity at 40° C. rather than at 25° C. This is purely a matter of convenience, however, from the standpoint of testing, as the same factors govern their viscosity limits as mentioned for oil products. Tars are more susceptible to temperature changes than are the oils, and their susceptibility factors vary considerably. It has been found, however, that for tars containing not more than the usual maximum limit of 10 per cent free carbon a specific viscosity at 40° C. of over 35 is apt to cause difficulty in distribution even in warm summer weather. This limit is, therefore, the maximum that should be allowed. A safe minimum for cool weather has been found to be 10 specific viscosity at 40° C. Within these limits the American Society for Municipal Improvements recommends that a range of 5 be allowed for any one job. Limits of from 10 to 25 for cool climates and from 20 to 35 for warm climates would, however, appear to be reasonably satisfactory for ordinary use.

Tars harden with relative rapidity upon exposure under atmospheric conditions, sometimes to the extent of becoming too brittle to give long service. On the other hand, petroleum products may not harden with sufficient rapidity to produce the desired resistance to displacement in the bituminous mat. In order to insure the necessary hardening properties of the latter, a consistency requirement for the residue obtained from the volatilization test is sometimes included in specifications. Thus for oil products the United States Bureau of Public Roads specifies a minimum float test of 90 seconds at 50° C. on the residue from the volatilization test, while for cut-back asphalts the American Society for Municipal Improvements specifies a penetration at 25° C. of from 50 to 85 for such residue. The maximum limit in the latter case is to prevent the use of too hard an asphalt in the manufacture of the cut back. No maximum limit is required for petroleum products owing to the presence of nonvolatile oils, which prevent undue hardening after application.

Bituminous Material for Hot-Surface Treatment.—For hot-surface treatment much more viscous materials may be used than for cold-surface treatment, but they should be sufficiently fluid at the temperature of application, 95° to 130° C., to be uniformly distributed at the proper rate, and before cooling after application should be fluid enough to saturate the surface of the road and firmly adhere to it. For oil products this will require a maximum specific visvosity at 100° C. of not more than 60 if the surface treatment of gravel as well as macadam roads is to be included. All tar products of suitable normal consistency are sufficiently fluid, at the temperatures of application previously mentioned, to apply satisfactorily, so that a consistency test at such range of temperatures is unnecessary. At normal temperature both oil and tar products for hot surface treatment should be too viscous to be satisfactorily tested with the Engler viscosimeter, and their consistency is probably best controlled by means of the float test at 32° C. In view of the maximum viscosity limit at 100° C. only a minimum float test at 32° C. need be specified for petroleum products without danger of securing too hard a material. For this purpose the United States Bureau of Public Roads has set a minimum float test at 32° C. of 60 seconds. The consistency of tar products for the same purpose, however, is limited by a minimum float test of 60 seconds and a maximum float test of 150 seconds at 32° C. in order to prevent the use of an undesirably soft or undesirably hard product. For reasons mentioned in discussing the cold application materials, specifications for petroleum products for hot application may include a minimum consistency requirement for the residue from the volatilization test. This limit may reasonably be somewhat higher, as illustrated by the United States Bureau of Public Roads specification in which the residue is required to show a float test at 50° C. of not less than 110 seconds, thus insuring a material which will harden after application.

---

*[illegible] High-

Use of Bituminous Materials in Road Construction.—Bituminous materials for highway construction are used according to the penetration method or the mixing method to coat the particles of mineral aggregate of the pavement throughout a depth of seldom less than 2 in. In the former case the material is applied to the pavement proper and while still hot must flow between the mineral fragments to the required depth and coat the exposed surfaces. Upon coming in contact with the broken stone a portion of it almost immediately congeals on the cold surfaces. The coatings of bitumen are therefore relatively thick as compared with coatings produced by the mixing method of construction. Stability of such pavements commonly known as bituminous macadam depends to a very great extent upon the interlocking of the large mineral fragments. Under traffic there is, however, more or less internal movement, so that eventually the bituminous material finds its way between the corners, edges, and surfaces in actual contact, although the coatings at such places are necessarily squeezed thinner than at other places. For this reason the bituminous cement should be sufficiently hard under conditions of service to prevent it from acting as a lubricant. On the other hand, it should be sufficiently soft to heal fractures or displacements due to internal movement. These factors are of such importance as to warrant limits of consistency based upon general climatic conditions to which the pavement will be subjected.

Because of the fact that tars harden materially after use they are required to be of softer original consistency than are the asphalt cements used for a similar purpose. They should be so soft in fact that they can not be tested by means of the penetration test made in the usual manner. Their consistency is usually specified by a float test at 50° C., which is approximately the maximum temperature the pavement is likely to attain. For general low-temperature conditions a float test at 50° C. of from 120 to 150 seconds is commonly specified and for high temperature conditions these limits are raised to from 150 to 180 seconds.

Consistency of Asphalt Cement.—Owing to their rapid hardening, especially when existing in thin films, and to their high susceptibility to temperature changes, tars are now seldom used in the mixed type of construction. Asphalt cements are almost exclusively used for such types, and as selection of their consistency limits for asphalt macadam, the various classes of asphaltic concrete, sheet asphalt, and other mixed types, involves many considerations common to all, they may best be considered collectively.

What may be termed the normal consistency of asphalt cements is determined and specified by means of the penetration test, the factors of temperature, loading, and time being 25° C., 100 grams, 5 seconds. In this test degree of firmness is determined by recording the distance that a standard needle penetrates a sample of the material under the above-mentioned conditions of temperature, loading, and time.

While certain rather wide limits of normal consistency have been found to be [illegible] suitable [illegible] of asphalt cements for the various types of construction, [illegible] standards of limits have been generally adopted for each type under accurately defined temperature and traffic conditions. It is recognized, however, that for any given type under otherwise similar conditions the warmer the climate the lower should be the normal penetration of the asphalt cement. In like manner, considering traffic as the only variable, it is recognized that the heavier the traffic the lower should be the penetration of the asphalt. As far as the types themselves are concerned, for all sheet or continuous forms of construction in which only a relatively small percentage of mineral particles pass the 200-mesh screen, it is also recognized that the finer the aggregate the lower should be the penetration of the asphalt cement. In connection with this statement, fineness of aggregate is meant to imply a weighted average diameter of fragment.

Classification of Climate and Traffic Conditions.—At the present time climatic and traffic conditions with reference to highways are dealt with under very broad general terms, which unfortunately do not always have the same significance in the minds of different individuals, owing to the fact that the terms are merely relative. Thus the terms low, moderate, and high are used to describe general temperature conditions. To the average mind it would seem that low temperature conditions might imply climates in which the winters are long and severe while the summers are relatively short and temperate. Moderate temperature conditions would also seem to imply climates in which neither winters nor summers are as a rule severe. On the other hand high temperature conditions imply climates in which the summers are long and hot and the winters short and mild.

There are, of course, certain localities where extremes of both winter and summer temperatures prevail for short periods, in which case an average of moderate temperature is reasonably safe to assume for the purpose of selecting suitable consistency for a bituminous material. Another method of classifying climate which is really based upon the factors just mentioned is to divide the United States into three belts or zones—northern, middle, and southern—the general temperature conditions of which are assumed to be low, moderate, and high, respectively. It will be found, however, that it is impossible to accurately bound these three zones with any parallels of latitude, as in many individual instances a locality within one zone will have a climate similar to the general climatic conditions of one of the other zones. Everything considered, therefore, the terms low, moderate and high may perhaps be preferable.

Terms commonly used to designate traffic conditions are just as broad as those used to denote temperature. In spite of the large amount of work on traffic classification, no satisfactory basis of classifying mixed traffic in units has as yet been devised. The terms light, moderate, and heavy are therefore commonly used. In general, light traffic signifies traffic in which the average load is relatively light and the number of vehicles passing per day is relatively small, such conditions prevail on most residential streets in cities and towns and on feeders to main state and county highways. The term moderate implies a somewhat more intense traffic than that just described, but one in which the average load is either not much heavier than that of a touring car, or if heavier does not occur in sufficient numbers to develop intense traffic. Many business streets in small towns, residential thoroughfares, park drives, main county highways, and state highways carrying principally tourist traffic fall in this class. The term heavy is used to designate both weight of average load and high intensity. Thus the principal business streets in towns and cities where trucking prevails or where the traffic is congested are said to carry heavy traffic. Many streets in shopping districts, boulevards, and main state highways also fall within this class.

Asphalt Penetration Limits.—Based upon the factors of climate and traffic just described, the Asphalt Association has published a table of penetration limits for asphalt cements to be used in various types of highway construction. This table is offered merely as a suggestion or guide to engineers in connection with the insertion of suitable penetration limits in a specification for asphalt cement which has been recently adopted by the association. As it is probably the most detailed table which has been published, it is here presented for the purpose of inviting discussion:

[illegible]	[illegible]	[illegible]	Moder-ate	High.
[illegible]	[illegible]	[illegible]	[illegible]-12[illegible]	8[illegible]-90
	[illegible]	[illegible]	[illegible]-120	80-90
	[illegible]	[illegible]	8[illegible]-90	80-90
[illegible]	[illegible]	[illegible]	70-80	60-70
	Medium	[illegible]	[illegible]-80	60-70
	Heavy	[illegible]	[illegible]-70	60-70
[illegible]	Light	[illegible]	[illegible]-70	50-60
	Medium	[illegible]	60-70	50-60
	Heavy	[illegible]	[illegible]-60	50-60
[illegible]	[illegible]	[illegible]	[illegible]-60	40-50
	Medium	[illegible]	[illegible]-60	40-50
	Heavy	[illegible]	[illegible]	30-40
Asphalt block	Light	[illegible]	[illegible]-25	10-15
	Medium	[illegible]	15-20	10-15
	Heavy	[illegible]	0-15	5-15

In connection with particular ranges of penetration, the Asphalt Association recommends that in any event a 10-point limit be allowed for asphalt cement of less than 90 penetration and that a 20-point limit be allowed for asphalt cement of over 90 penetration. Such limits may readily be met under ordinary manufacturing conditions and are sufficiently close to insure uniformity in connection with other requirements of the specifications. It will be noted that the limits apply only to the normal conditions of test, no requirements being included for penetrations at 0° C. or at 46° C. It is believed that with the materials now on the market penetration requirements at temperatures other than 25° C. are unnecessary, provided the 10 or 20-point range is adhered to as recommended. So far as actual consistency of the asphalt cement is concerned, when the temperature of the highway is 25° C., it is evident that the limits are comparatively close, considering the ordinary susceptibility of asphalt cements to temperature changes. Such limits are, however, advisable in order to insure that the product will not become too hard in cold weather nor too soft in hot weather. If the limits were materially increased, then requirements of penetration at either 0° C. or 46° C., or both, might be advisable, according to climatic conditions under which the material would be in use.

In connection with this table it is of interest to note that the penetrations of asphalt cement for asphalt block are very much lower than for any of the other types of pavement. This is allowable for two reasons, irrespective of the [illegible] grading of the aggregate, which in itself would not warrant such low penetrations. In the first place, a blown type of asphalt is specified for asphalt block, a ductility requirement of from 5 to 8 being made. Such asphalts are less susceptible to temperature changes than the more ductile products specified for the other types of construction, and do not become relatively as hard in cold weather. In the second place, in asphalt block construction, prevention of contraction cracks does not have to be considered as in the case of the sheet types of construction. The necessity of using a harder asphalt cement than for the sheet types exists because of the fact that after manufacture the blocks must withstand rather rough handling during shipment and prior to laying without distortion or breakage.

Table Offered as Suggestion, Not Standard.—While in general the table of limits takes into account fineness of mineral aggregate in so far as classification by types of construction is concerned, ordinary grading requirements for any one type are usually so broad that certain gradings within specification requirements may make it advisable to adopt a higher or a lower range of penetration limits for a given combination of climatic and traffic conditions than the range shown in the table. For this reason the table has been offered more in the way of suggestion than for adoption as standard. It is practically impossible to define the most suitable consistency limits for every conceivable grading which is encountered, but fortunately experience has already demonstrated to those engineers who are obliged to use certain aggregates, such as those from a given deposit, what penetration limits are best to use. In any event [illegible] of a [illegible] [illegible] recommended is not apt [illegible].

[illegible] sieve [illegible] asphalt [illegible] asphalt [illegible] does [illegible] nor [illegible] other [illegible] asphalt [illegible] create [illegible] A softer asphalt [illegible] coarser aggregates such as sheet asphalt or Topeka. Penetrations of 90 or 100 have been successfully used under such conditions. The use of a relatively soft asphalt cement is, moreover, desirable because of the fact that asphalt-earth mixtures are not as susceptible to the kneading action of traffic and means must therefore be provided for internal adjustment to meet the tendency to crack in cold weather due to contraction of the pavement.

Character of Aggregate as a Factor.—One factor bearing upon the proper consistency of bituminous materials which was mentioned in the first part of this paper is often of considerable importance. This is the character of the aggregate. Most aggregates composed of fragments in which quartz, feldspar, and other hard minerals predominate require asphalt cements of about the penetration ranges shown in the table. When the fragments are of soft limestone, however, the use of softer asphalt cements than indicated may be proper. Thus in the construction of asphalt macadam roads with the very soft coraline rock of Florida, an asphaltic oil ordinarily suitable only for hot surface treatment may be used successfully as a binder. This would not be practicable with the harder rocks. The reason lies in the fact that the fine limestone dust which is worn off of the larger fragments amalgamates with the asphalt films to form a tough mastic of higher frictional resistance than the asphalt itself. This property, possessed also by Portland cement, is utilized in the manufacture of paving mixtures where limestone dust or Portland cement is incorporated as filler. The presence of filler toughens the mix and produces a mixture less susceptible to temperature changes.

Fillers for Brick and Block Construction.—The proper consistency of asphalt fillers for brick and block construction depends mainly upon climatic conditions and how the filler is used. For poured or squeegeed joints a partially blown type of asphalt has been adopted by the Asphalt Association with a minimum penetration requirement of 10 when tested at 0° C., under a load of 200 grams for one minute. This is to prevent the filler from becoming too brittle in cold weather. Normal penetration limits of from 40 to 50 for low temperature conditions and from 30 to 40 for high temperature conditions are suggested. In order that the filler may not become unduly soft and bleed in warm weather, a minimum melting point of 65° C. (ring and ball) is specified. A maximum melting point of 100° C. is also specified in order to insure its workability at the temperature of application and to allow sufficient time for it to flow into the joints before it congeals.

When a filler is to be applied as a grout after being mixed with hot sand, an unblown asphalt cement has been used with satisfactory result. Because of the fact that the sand materially stiffens the filler, it may be softer than the poured filler and a 20-point penetration limit at normal temperature is believed to be sufficiently close for all practical purposes. For low temperature conditions such a limit between 70 and 100 is suggested, while limits of 50 to 70 are suggested for high temperature conditions. Such ranges prevent the grout from becoming too brittle in cold weather and from bleeding in warm weather.

In order that asphalt cements may not be injuriously hardened when they are heated up to and maintained for reasonable periods at the maximum temperature of application, it has become customary to specify that the residue from the volatilization test at 163° C. shall show a penetration of not less than 50 per cent of the penetration of the original material. This is merely a precautionary requirement, however, as under ordinary conditions of heating in practice no asphalt cement will harden to anywhere near this extent.

Results of Service as Guides.—After all, the best guide to selection of the proper consistency of bituminous materials is experience, and it is upon service results rather than upon theoretical considerations that most of the consistency limits have been selected. Service results may, however, sometimes be misleading in this connection, and other factors than consistency should receive due consideration in attempting to analyze such results. Thus the use of too soft a bituminous material may result in the pavement shoving under traffic and also bleeding. The use of an excess of bituminous material of proper consistency may, however, cause both defects. Shoving may also be caused by lack of compaction or poor grading of the aggregate. The use of too hard a bituminous material promotes cracking of the pavement and sometimes causes it to break up or disintegrate under traffic.

An insufficient quantity of material of suitable consistency, poor aggregate grading, and poor compaction may also cause these defects. Overheating or burning the bituminous material may also be responsible.

In conclusion, there appear to be at least two promising and useful lines of investigation in connection with the consistency of bituminous materials: (1) Working out a method of expressing consistencies in comparable form for all ranges from very fluid to practically solid, and (2) devising a method for accurately determining the [illegible] or resistance to displacement of compacted bituminous aggregates.

Results of Traffic Censuses and Their Application

Interesting information on the [illegible] highway traffic censuses was given by Mr. W. A. McLean, Deputy Minister of Highways of Ontario, in a paper presented June [illegible] at the 7th Canadian Good Roads Convention. An abstract of the paper follows:

Potential Traffic and Existing Traffic.—The value of traffic census has limitations which are at once evident. Thus, the amount of traffic which will pass over many roads after construction, may bear little relation to the traffic over the unimproved road. In such cases, it is the potential traffic of a district which should be considered, rather than existing traffic, but definite data, obtained from actual count, [illegible] in determining the probable traffic which the improved road will be called upon to carry. Thus on the Toronto-Hamilton highway, traffic amounted to from 400 to 700 vehicles at various points, but with the completion of the concrete pavement these figures leaped to 2,700, between the hours of 7 a. m. and 7 p. m.

The potential traffic of a district, preceding the construction of a road, is a matter for careful estimate, just as the available traffic for an electric or steam railway may be based on the population and industries served. A somewhat interesting series of charts was published in the report of the Ontario Highway Department for 1915, a net result of which was to show that not less than 80 per cent of the traffic of the province is carried by 20 per cent of the highways, that 80 per cent of the roads are but lightly traveled, and are such as can be adequately built with a single track of gravel or broken stone. Also that few roads serving a purely rural population would be required to carry a maximum of traffic much in excess of an average of 200 vehicles a day.

Traffic in excess of that amount, except adjacent to the largest cities, may usually be attributed to interurban [illegible].

Application of Traffic Census Results to Road Design.—Knowing the potential traffic of a district, the highway engineer turns to data of the carrying capacity of various types of road and pavement—a matter in which there is room for much diversity of result. For example, limestone gravel has less wearing capacity than a gravel from trap or granite. The foundation, and subsoil have a decided bearing on the case. Roughly, and with scope for much modification, the wearing capacity of various materials as used in Ontario may be broadly gauged from the following schedule:

	Single-horse	Two-horse	Light trucks or passenger	[illegible]	[illegible]
Single-track gravel	4	1[illegible]	[illegible]	[illegible]	[illegible]
Double-track gravel	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Water-bound macadam (single-track)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Water-bound macadam (double-track	[illegible]	[illegible]	[illegible]	1	[illegible]
Double-track gravel, oiled or tarred	17[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Double-track macadam, oiled or tarred	2[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]
Macadam, penetration bituminous	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Macadam foundation, bituminous concrete	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Bituminous concrete on cement concrete foundation	2[illegible]	[illegible]	4[illegible]	[illegible]	[illegible]
Cement concrete	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The Ontario Traffic Census.—The first census in Ontario was taken between Oct. 15th and Nov. 1[illegible]th, 191[illegible], at 20 stations on representative county roads, a large number being now part of the provincial highway system. The count was taken for seven consecutive days from 7 a. m. to 7 p. m., and classification of vehicles was divided into: 1 horse light; 1 horse heavy; 2 horse light; 2 horse heavy; motor runabouts; touring cars; and motor trucks.

Enumerators were provided with a card for each day with columns for each 2 hour period; for each of the above classes of vehicle a space was provided. The method of recording was by making one tick for each vehicle. The ticks were added and checked by the inside staff of the department. The conditions of roads and weather were specified. Owing to the choice of a period when traffic was particularly light, a minimum traffic census was thus obtained.

A second census was taken at the end of July and the beginning of August, 1914, at 21[illegible] stations on roads radiating from 21 cities, for seven consecutive days from 7 a. m. to 7 p. m. The classification of vehicles was the same as in the first census, the condition of road and weather being described. Additional information bearing on local industries and peculiarities of traffic, was also secured.

Censuses for certain localities were taken in 1915, in 1917, and in 1918.

Results of Traffic Counts in Massachusetts and Iowa.—In Massachusetts, a traffic count has been made at three-year periods since 1909. The actual count is made for 14 hours a day (7 a. m. to 9 p. m.) for seven consecutive days in August, and seven in October. The count is also made at night at a few important points so as to cover the whole 24 hours. The classification is divided into light and heavy horse-drawn vehicles, automobiles and light trucks, and heavy trucks. The following is a table of assumed weights:

	Tons
Runabouts	1.4
Touring cars	[illegible]
Trucks	[illegible]
1 horse light	[illegible]
1 horse heavy	1.1
2 or more horse light	[illegible]
2 or more horse heavy	[illegible]

The result of the census shows the percentage of each class and the percentage that each class is of the total traffic.

Thus in nine years the total average daily traffic on roads has increased 243 per cent, the total motor traffic has increased 561 per cent, while in six years' time the number of heavy trucks has increased 341 per cent.

In Iowa an interesting census was made in 1917 by the Engineering Experiment Station of Iowa State College from seven to ten days. Scales were set up covering one-half of the width of the road; a huge sign was put across the road, and the driver of every car was halted and interrogated. This census enabled the state to ascertain:

1. Total number of vehicles.
2. Character of traffic, whether farm, interurban or tourist.
3. Percentages of horse-drawn and motor vehicles.
4. Tonnage of traffic.
5. Width and character of tires.

In ten days in June, 1917, near Ames, Ia., on Ames-Des Moines road, there passed a total of 1,995 vehicles of which 647 were farm traffic, 1,227 interurban and 121 tourist. These vehicles carried 1,761 passengers, and weighed 1,919,156 pounds gross. Of the total number of vehicles, 1,752 were motor vehicles and bicycles, and 243 were horse-drawn. The exact basis of farm and interurban traffic was difficult to determine, but it was considered that farm traffic included traffic originating or terminating at the farm, or doing business in passing, e. g., mail. Thus 32 per cent was farm traffic, while 84 per cent was local.

Some American cities favor three enumerators at one station: one man to call out classification, the second to mark down the tick, and the third as relief man. This allows for a continuous count to be made in shifts, one man resting.

Counts in Great Britain.—The United Kingdom methods may be illustrated by a traffic census on the roads radiating from Stirling, Scotland, taken in August and September, 1911, covering 16 hours a day (6 a. m. to 10 p. m.), for seven consecutive days. An assumed average weight was given to each type of vehicle, and, the width of carriage way being given, the total weight in tons per yard width was ascertained. This assumed weight differs very little from that used in the Massachusetts censuses. The British Road Board Traffic Form is followed, and each traffic enumerator is provided with a small sketch plan to show the exact spot where census is taken.

In London yearly censuses are taken on such thoroughfares as Fleet street, and Putney Bridge for twelve daylight hours on one day, and are chiefly used for determining density of traffic than wear to pavement.

City Planning Reports and Graphic Representation of Statistics

[illegible] the Town Planning [illegible] George B. Ford [illegible] the American [illegible] interesting outline of [illegible] American practice [illegible] practically in full follows.

[illegible] A good idea is worth little by [illegible] Theory must be fol[illegible] are the opportunities for an au[illegible] theory. Almost always the public [illegible] This means education and [illegible] appetite for the new idea. The old way [illegible] was slow and required a lot of patience. The [illegible] We want to realize our ideas right away. (Of course, if they are bad, this gives us a chance to correct them before too much damage is done.)

Therefore the American town planners have been quick to apply to their own problems the experience of the business world in advertising psychology. In a word, this art consists in a study of the receptivity of the average human mind. Among the multitudinous impressions that are constantly being made on the mind, what sort sticks the longest and are most likely to result in action? Of course, too, in a country surfeited with advertising, the town planner [illegible] arrest the attention of the blase public; otherwise his ideas, no matter how good, are just lost in the crowd.

Educating Public Half of City Planning Work.—Thus we have come to consider education as half of our city Planning work and incidentally we have found this presentation of our ideas most beneficial technically. For this very expression of our ideas in a way that the public must understand shows up glaringly the weak points and helps us in general to clarify our thought.

The character of the presentation of our ideas depends on whether we are trying conscientiously to find the solution of a problem or whether once found we are trying to persuade first the technicians and second the man in the street to accept our findings. The first in all honesty implies a straightforward, unimpassioned type of presentation that will fool neither the technician nor ourselves—no tricks, just a bald statement of facts. For the other, whether it be the town council or the property owner affected, or the press or the average layman, any trick of presentation is legitimate that will "get over" our ideas once we are sincere in believing they are most worth while.

[illegible] in general is carried on in all three ways, placed in the order of their relative effectiveness: (1) by printed [illegible], preferably illustrated, (2) by lectures and talks, preferably with stereopticon or cinema and (3) by exhibitions. We consider the newspaper the most effective medium and next the attractive report or pamphlet widely distributed. Both should be illustrated in a way that will catch the eye, [illegible] with "before and after" views and plans. Colored views and plans are most desirable, but rarely practical on account of their cost and the technical difficulties of reproduction. [illegible] are especially suited to reports [illegible] newspapers. All these can be used with the stereopticon and the cinema, and all three, especially [illegible] in exhibitions.

[illegible] it is ob[illegible] but [illegible]

[illegible] it is well to have [illegible] undertaking. [illegible] comes the "survey," [illegible] facts about [illegible] improvement. [illegible] plans and charts [illegible] the time available. [illegible] analyses and preliminary studies [illegible] by the technician only. These are followed by general preliminary plans to be submitted to the local authorities for their approval in principle. Once approved, these plans are worked up in such detail as existing property and highway plans will permit, to show exactly what land is to be expropriated or retroceded so that the plans can be used for public hoardings. It is desirable at the same time to expose and publish plans and articles showing attractively the future towns and the advantages of the improvement as proposed. For this purpose perspective, bird's-eye views, aeroplane photographs, etc., are particularly useful.

Then modifications have to be made in the official plans submitted to public hearings, then the plans are for their approval. Finally they are adopted by the local authorities and then worked up in detail by the town engineer. This final stage in particular demands completed surveyor's plans of the existing town.

The scale of the plans is important. Preliminary and schematic studies and certain pictures of the surrounding country can be made at the scale of 1/20,000th—that is, about 3 in. to the mile; 4 in. to 6 in. to the mile is better. Most of the surveying plans, some of the preliminary plans, and the general "hearing" plans can be of the scale of 5/1,000th or 1 ft. = 1 mile or 1 in. equals 400 to 500 ft. Most of the "hearing" plans and the other official plans could well be at the scale of 1/1,100th or 1/90th to 1/100th of 1 in. equals 1 ft. Details can be at the scale of 1/100th or 1/200th or 1/40th to 1/50th of an inch equals 1 ft. and 1/16th of an inch equals 1 ft. It is an excellent idea to place a graphical scale in a prominent corner of each drawing, especially if there is any possibility of the drawing being photographed or reproduced.

Standardized Drawings. It helps greatly in handling and classifying drawings if they are standardized in form and size. We have been using for some time the standardized unit of the International Bibliographic Institute in Belgium, that is, letter size (8½ by 11 in.). Every drawing that is made in multiples of these dimensions can be folded easily to letter size to file with letters or to be mailed with them. Any drawing the same number of multiples of 8½ in. and of 11 in. in both directions can be easily photographed down to letter size.

We usually put the title in the upper right-hand corner. For a series of drawings on the same job it is useful to have the title always in the same corner. If the drawing is an odd number of multiples of letter size it is quite feasible by folding the drawing accordion fashion in both senses to have any one of the four corners on top for convenience in filing. The name of the town, the filing number, the subject of the drawing, the name of the author, the status of the drawing, the scale, the orientation, the table of symbols used, and any other explanatory notes should all come within the 8½ in. by 11 in. that will appear on top when the drawing is folded. Furthermore, the lettering should be large enough so that it can be easily photographed down to a small scale.

In choosing the symbols to be used in any given drawing, the two prime considerations are that they be readily understood by the average layman and that they should be easily reproducible in a newspaper or a report. We usually start our data and our study drawings in colored crayons or pencils, and we almost always make our field notes with colored pencils. Drawings for hearings, for town files or for color reproduction, we usually make in water color or an ink line drawing. In the recent competition for plans for Paris a number of beautiful drawings were presented in gouach on soft gray photographic enlargements. For special cases colored inks or even oils are useful.

The Use of Colors.—In general it pays from the layman's standpoint to use colors that have a certain association—i. e., blue for water, green for parks and playgrounds, red for railways, brown for industrial districts, etc. However, for data plans every case has to be decided for itself. The chief deciding feature is contrast—i. e., to find for the most recurrent symbols colors that stand out from each other. For example, red, blue and yellow contrast much better than blue, green and violet. Incidentally yellow should always be strong enough to stand out under artificial light.

Another use for colors is to indicate modifications on black and white drawings. For example at Rheims the drawings submitted to the public in the first public hearings were black and white, "Dorel" prints. As the second series of public hearings were only on the modifications made by the city council to the former drawings after the first hearings, we show the modifications in color with gouach directly on the original black and white prints.

In France red is the standard color for land to be expropriated and yellow for municipal land to be retroceded or sold to private individuals. We [illegible] the use of yellow to the suppression of previous modifications and use blue to represent expropriation of second urgency.

When we come to exhibition drawings the color combinations are limitless. The color drawings of Jules Guerin for the Chicago, Portland, and Minneapolis town plans by E. H. Bennett are well known for their exquisite harmony. The most beautiful presentation of plans [illegible] of the first prize drawings by Leon Jaussely in the recent Paris planning competition. On the soft gray background of photographic enlargements he has applied striking combinations of color with parallel lines of warm gold about [illegible] apart superimposed to bring out certain portions.

Black and white present many more difficulties. In some cases washes graded from light gray to black can be used effectively for photographic reproduction. In the plan (scale 1 1,000th) that we made showing the present state of the center of Rheims, we used four grades from light gray for completely destroyed buildings to black for intact buildings and historical monuments.

For exhibition purposes Conté crayon or charcoal with washes of gray and gouach can be used to excellent advantage.

Ink Drawings.—The most serious medium for the graphical presentation of town planning data and ideas is black ink which has the double advantage where the drawings are made on tracing cloth or paper, of making easily possible black and white contact prints or reproduction by the cheap line-cut process, even on the rough paper of the average newspaper. This implies that, in view of a considerable reduction in size, every line, every figure, every letter, should be reasonably large and heavy.

At Rheims we made a number of experiments with various sorts of indication, and secured our best results by representing in solid black on a black line plan of the existing town all proposed immediate appropriation for street widenings, extension, parks, etc., and in alternating black and white squares for future appropriation. Sites for public buildings were indicated with heavy dots, and parks and playgrounds by hatching in one direction only. The general public at the hearings seemed to be able to read these drawings readily.

After the plans were adopted we made new ink drawings on tracing cloth showing the existing plan with light lines, superimposing the proposed plan in heavy lines and the lesser urgency changes in heavy dash lines. Building set back lines, we indicated with heavy dots and parks and playgrounds by irregular scalloped lines with an irregular infilling of dots. Incidentally this drawing provided excellent prints for making water-color drawings for exhibition purposes.

On a print of the above made on tracing cloth we showed the existing state of the town by indicating in solid black the buildings that are most worth preserving and by alternate bars of black and white other buildings that are more or less repairable. The rest of what was built-up part of the town was indicated by simple hatching in light lines with public buildings in cross-hatching.

The two most necessary data plans seem to be one which shows the existing use of property and another which shows land values. The former we expressed on our studies for Arras by indicating industrial property by cross-hatching, residential by simple hatching, commercial by solid black, and gardens and unbuilt property by white.

Land values are conveniently represented by curves similar to elevation contour lines.

In reports, pamphlets, newspaper articles, lectures and exhibitions the use of tables, diagrams, and charts is almost always effective. For one's own benefit, as well as that of the layman, it is almost always useful to take the trouble to plot out comparative charts and tables.

In general, getting the public to accept a scheme for improvement is half the battle. It is therefore desirable to present all ideas and supporting data to the public in such a way that they can and will easily absorb it. Most people absorb ideas through the eye more easily than through the ear. Thus every attention should be devoted to the psychology of presentation; to so express ideas that they will "get over" easily and attractively.

Proposed Tests for Clay and Silt in Road Materials

The determination of the quantity of clay and silt in natural gravel, sand-clay, top soil and semi-gravel is frequently of considerable importance in the selection of suitable products for road construction purposes. Considerable variation exists in the methods used by different laboratories. As a step toward unifying present practice the Committee on Road Materials of the American Society for Testing Materials submitted at the recent convention of the society, the following proposed tentative methods.

Quantity of Clay and Silt in Gravel.—This test covers the determination of the quantity of clay and silt in natural gravel to be used in highway construction.

The sample as received shall be moistened and thoroughly mixed, then dried to constant weight at a temperature between 100 and 110° C. (212 and 230° F.)

A representative portion of the dry material weighing not less than 50 times the weight of the largest stone in the sample, shall be selected from the sample, and placed in a dried and accurately weighed pan or vessel. The pan shall be 12 in. (30.2 cm.) in diameter by not less than 4 in. (10.2 cm.) deep, as nearly as may be obtained. Pour sufficient water in the pan to cover the gravel and agitate vigorously for 15 seconds, using a trowel or stirring rod. Allow to settle for 15 seconds, and then pour off the water into a tared evaporating dish, taking care not to pour off any gravel. Repeat until the wash water is clear. Dry the washed material to constant weight in an oven at a temperature between 100 and 110° C. (212 and 230° F.), weigh, and determine the net weight of gravel.

The percentage of clay and silt shall be calculated from the formula:

$$\text{Percentage of clay and silt} = \frac{\text{Original weight} - \text{weight after washing}}{\text{Original weight}} \times 100$$

For a check on the results, evaporate the wash water to dryness and weigh the residue:

$$\text{Percentage of clay and silt} = \frac{\text{Weight of residue}}{\text{Original weight}} \times 100.$$

Quantity of Clay and Silt in Sand.—This test covers the determination of the quantity of clay and silt in natural sand to be used in highway construction.

The sample as received shall be moistened and thoroughly mixed, then dried to constant weight at a temperature between 100 and 110° C. (212 and 230° F.).

A representative portion of the dry material, weighing 500 g., shall be selected from the sample, and placed in a dried and accurately weighed pan or vessel having vertical sides and provided with a pouring lip. The pan shall be substantially 9 in. (22.9 cm.) in diameter by not less than 4 in. (10.2 cm.) deep. Pour sufficient water in the pan to cover the sand (about 225 cc.) and agitate vigorously for 15 seconds. Allow to settle for 15 seconds, and then pour off the water into a tared evaporating dish, taking care not to pour off any sand. Repeat until the wash water is clear, using a glass rod to stir the material for the last few washings. Dry the pan and washed sand to constant weight in an oven at a temperature between 100 and 110° C. (212 and 230° F.), weigh, and determine the net weight of sand.

The percentage of clay and silt shall be calculated from the formula.

$$\text{Percentage of clay and silt} = \frac{\text{Original weight} - \text{weight after washing}}{\text{Original weight}} \times 100$$

For a check on the results, evaporate the wash water to dryness and weigh the residue.

$$\text{Percentage of clay and silt} = \frac{\text{Weight of residue}}{\text{Original weight}} \times 100.$$

Quantity of Clay in Sand-Clay, Topsoil and Semi-Gravel Highway Construction.—This test covers the determination of the quantity of clay in that portion of sand-clay, topsoil, and semi-gravel for highway construction which passes a 10-mesh sieve.

Dry 500 g. of the material at a temperature below 176.6° C. (350° F.) to a constant weight. Gently pulverize to break down soft clods or masses, but not to grind or break hard material. Pass through a 10-mesh sieve, weigh the coarse residue and record as "coarse material." Use the material [illegible] a percentage [illegible].

[illegible] material for du- [illegible] bottle 5 [illegible]. Add about 5 [illegible] of water. [illegible] stopper and shake thoroughly [illegible] the sample to settle 8 minutes and [illegible] of the supernatant liquid to a [illegible] of the liquid. (The depth [illegible] should be sufficient to leave about [illegible] of sediment.) Fill the bottle again [illegible] allow to settle and siphon [illegible] until the supernatant liquid [illegible] the stopper and neck of the [illegible] material before decanting. Dry the [illegible] material to constant weight at a temperature [illegible] C. (212 and 2[illegible] F.), weigh, and [illegible] weight of washed material.

[illegible] shall be calculated from the [illegible]:

$$[illegible] = \frac{\text{[illegible] weight after washing}}{\text{Original weight}} \times 100.$$

[illegible] the washings drawn off shall be collected and [illegible] for direct recovery of the fine sediment [illegible]:

$$[illegible] = \frac{\text{Weight of residue}}{\text{Original weight}} \times 100.$$

[illegible] on the two samples shall check within [illegible] percentage of clay to be acceptable.

Tearing Up Asphalt Pavement with Rooter Plow

[illegible] hauled by a 5-ton Holt caterpillar [illegible] employed by the Marion County Construction Co., Indianapolis, for ripping up an old asphalt pavement on [illegible] St., Indianapolis, preparatory to resurfacing the [illegible]. With this outfit 1,300 sq. yd. of pavement was torn up in [illegible] hours. The work required 4 men at the plow and the tractor operator. An analysis of the cost for these five men and the tractor, including interest on the investment of the tractor, depreciation, maintenance, repairs, fuel and [illegible] at 70 ct. per hour result in a unit cost of [illegible] per square yard or approximately $11 for the [illegible] city block of asphalt pavement.

Ripping Up Old Asphalt Pavement with Ordinary Rooter Plow Hauled by Tractor.

Engineering Graduates at Illinois. At the commencement of the University of Illinois on June 1[illegible], 1920, and at various [illegible] during the year, [illegible] of science degrees were [illegible] College of Engineering distributed as follows:

[illegible]	18
[illegible]	24
[illegible]	6
[illegible]	39
[illegible]	1
[illegible]	1
[illegible]	1
[illegible]	[illegible]
[illegible]	7

Recognition to Be Gained Through Writing

By RUTH CANAVAN,

Librarian with Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston.

Probably every young man who adopts engineering as his profession does so with the hope that he may rise to the top. Having obtained his education he devotes himself to its practical application under the guidance of experienced engineers. The first year or two of obscurity do not dismay him, but if recognition and advancement do not follow within a reasonable time, he becomes dissatisfied. How is he to make his personality felt; how is to get his ability recognized?

First of all, let him consider as impartially as possible, whether or not he has entered the particular branch of engineering for which he is best fitted. If he decides that he has not or that his position does not offer a good opportunity for advancement he should take immediate steps to make a change.

There are several ways in which he can go about this. If his employer, or his chief, has shown himself to be a man of sympathetic understanding, the young engineer may go to him with frank statement of his case and an appeal for suggestions and assistance. Or he may turn to his former professors for help, or file application with the Engineering Societies Employment Bureau, 29 W. 39th St., New York City, or with the local or national society of engineers practicing in the field which he wishes to enter. He may also advertise in the engineering periodicals, the society journals or the newspapers.

Having placed himself in a line which appeals to him and satisfied himself that he has a fair prospect for advancement and success, the ambitious young engineer tries to demonstrate his worth—to be open-minded, receptive and acquisitive of information. He supplements his preliminary education by systematic reading and study. Still material advancement does not come. He asks himself why. He has yet to make his personality felt. There are two ways to do this.

The first is to join an engineering society. Here he will come into contact with other men and form stimulating and valuable friendships. He may interest himself in the society's activities and take part in the discussions whenever he has anything of interest to add.

A second and effective way of making himself known is by writing. Not everyone can become an author, but everybody can acquire the faculty of expressing simply and grammatically what he wishes to say. First, of course, he must have something to say. He must have a higher motive than simply the desire to "get into print." He should have the desire to serve others. Whatever specific knowledge he gains as a result of his practical experience or studies, which he thinks would be likely to prove helpful to other engineers, he should contribute for their information.

"But my experiences are so trivial," argues the young engineer. "It is only the details that are entrusted to me. The big job gets written up by the big man [illegible] the man who planned it or the man who supervised it.

True, but the big man based his big job upon the very details which appear to be so trivial, and these details it is difficult to find in print. With comparatively little search one can find articles upon the construction of dams, covering choice of type, method of construction and cost, but it is not such a simple matter to discover what influenced the proportioning of the concrete aggregate, what waterproofing substance was used, the quality of [illegible], the slope of chute, and a thousand-and-one other details to which consideration was given in making the recommendations and by which every engineer faced with a similar problem would be glad to benefit.

To take another instance—in the [illegible] of state departments of health may be found plenty of reports upon the pollution caused by the discharge of trade wastes into streams, but very few such publications contain detailed analyses of the wastes in question. Yet when asked to provide for the treatment or disposal of similar wastes this is the first thing that the engineer needs to know, and he turns from the documents in question with a feeling of disappointment that he cannot profit by the results already obtained.

There are plenty of things which not only can be written about but which would make valuable additions to scientific literature if only the engineer would recognize their fundamental significance and the possibility of their application to the problems of others. The material which the engineering press is eager to publish is not, however, information of a speculative or theoretical nature, or compilations of data already in print, but it is the detailed results of practical investigations or of construction or operating experience.

There is, of course, the limitation imposed by the fact that all of the engineer's computations, his field books, his plans, etc., belong to the organization which employs him and that it is only with the sanction of his chief that the results of his investigations may be given out for publication. Occasionally it happens that the head of an organization will be so short-sighted as to frown upon the ambitions of his subordinates in this connection, but usually he will be found to sympathize with their aspirations, realizing that anything creditably accomplished by them reflects credit not only upon the organization but upon its chief as well.

A clearly written exposition of significant results will go a long way toward winning for the young engineer the recognition not only of his employer but of engineers in all branches of the profession.

Highway Engineers Wanted for U. S. Bureau of Public Roads.—The U. S. Civil Service Commission will hold an open competitive examination for highway engineer. Vacancies in the Bureau of Public Roads, Department of Agriculture, for duty in the field, at entrance salaries ranging from $1,200 to $2,700 a year. The duties of this position involve superintending the construction of roads of various types throughout the United States and co-operating with State Highway Departments in connection with the provisions of the Federal Aid Road Act. In addition, appointees will be called upon to inspect roads and investigate road-building materials, administrative organization, and methods of management; to inspect roads locally, and give advice in regard to their improvement, etc. The work will also include inspection and review of plans and specifications. Applications will be received by the Civil Service Commission, Washington, D. C., until September 9.

Average Costs of New York State Highway Pavements.—The following tabulation showing the average costs of New York State pavements are abstracted from a statement made public recently by the State Highway Commission:

	Per mile 16 ft. pavement.
Minimum bituminous pavement on sand or gravel	$22,157
Minimum reinforced concrete pavement	2[illegible],[illegible]63
Heavy bituminous pavement on clay or loam	[illegible]8,549
Heavy reinforced concrete pavement	28,544
Mixed bituminous top on concrete foundation	[illegible]2,[illegible]54
Brick on concrete foundation	[illegible]2,587

The costs were compiled by the division engineers of the nine divisions of the state. The figures given above are the average for the nine divisions. The prices cover the pavement only, and do not include grading, culverts, drainage, grade, rail, etc.

Bituminous Surface Treatment for Heavy Traffic Gravel Roads

The State Highway Commission of Maine, of which Paul Sargent is Chief Engineer, has under its care a considerable mileage of gravel surfaced state highway which carries excessive motor vehicle traffic. On one of these roads, for instance, official counts have shown as many as 1,5[illegible] motor vehicles passing a given point in the 12 hours from 7 a. m. to 7 p. m. This number was a daily average for one week. The sections subjected to heavy traffic have been given a bituminous surface treatment in order to preserve them. The method employed is outlined as follows in the report of the State Highway Commission for 1919:

Surface treatment can only be successfully applied to a clean, well bonded surface having a true cross section. The first step is the distribution of clean, coarse and sharp sand along the shoulder of the road in piles about [illegible] ft. apart, using about 10 to [illegible] cu. yd. per mile. This sand is used to cover the bituminous material after it has been spread upon the road. The next step is to thoroughly clean the surface with a horse sweeper and hand brooms, in this way removing all dust and loose material. The bituminous material is then spread from a pressure distributor tank mounted either on an automobile truck chassis or drawn by horses. The amount of bituminous material per square yard of surface depends on the condition of the surface and as a general thing good results will not be obtained by making a uniform distribution over the whole area because it is very rare that any considerable area will present exactly uniform conditions. This means in practice that more or less material per square yard must be used according to the condition of the surface. In the Maine practice the amount of bituminous material is controlled entirely by the judgment of the man in charge of the work. He rides on the truck and from his knowledge of the conditions determines the amount of pressure to be applied to the tank, the opening of the valves that control the flow of the tar, and the speed of the truck. On new surfaces the rate of distribution will vary from 0.4 gal. to ½ gal. per square yard. The second, third or fourth years, the application may be as light as ¼ gal. per square yard and usually is from 0.3 to ¼ gal.

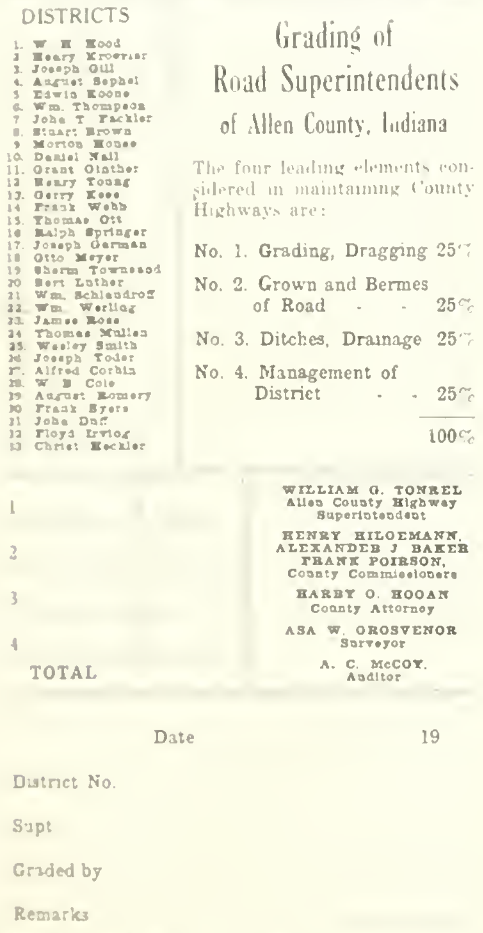
This work must be done on a warm day and on a dry surface. If traffic conditions would permit the commission would allow the bituminous material to penetrate the surface six hours before covering with sand, but it has been found necessary to immediately cover with sand from the piles alongside the road to keep the bituminous material from stripping up under steel tire traffic. Furthermore, there is great liability of automobiles skidding on the fresh bituminous material, and this is another reason for immediately covering with sand. About one-half the sand is immediately applied and during the next three or four days a few men are left behind to sand spots which show an excess of bituminous material as they appear. This means going over the same length of road several times. It is very important that the smallest possible amount of bituminous material be used that will preserve the surface.

Except where drainage and foundation conditions are absolutely perfect this bituminous surface treatment will break up the following spring. It is very necessary where the breaking up occurs that the surface be reshaped by using the road machine and the drag. The surface must be kept in shape until it is settled and bonded when another application can be made following substantially the steps outlined above, but using less bituminous material.

After three or four successive annual applications certain portions of the surface will become wavy. It is then necessary to break the surface by the use of a pressure scarifier or spike tooth harrow. It is sometimes necessary to plow short sections and for this the point of a road machine blade may be used. After this course has been broken up it must then be pulverized. This may be done with a spike tooth harrow or a steam roller with the picks. It also pulverizes more or less under travel. The pulverizing process can be hastened by working the material from one side of the road to the other with a road machine, letting travel break it up as much as possible. It is usually necessary to use a road machine every other day from the time the surface is broken until the road is bonded for another treatment. The more this material is worked over the more completely it will pulverize and a better surface will be presented for [illegible] treatment. [illegible] pr[illegible] of the next treatment [illegible] It may be necessary [illegible] preferably [illegible] excess of clay. The [illegible] that a quantity of finely pulverized [illegible] about equal to the [illegible] per mile, has [illegible] surface for re[illegible]. The [illegible] this surface after being [illegible] with the original treatment, be[illegible]. During the spring of 1919 a [illegible] was broken up and retreated [illegible] very excellent results.

Rating Local Road Superintendents

An interesting method of rating the work accomplished by local road superintendents is employed by William G. Tonkel, County Highway Superintendent of Allen County, Indiana. The road system of the county is divided into 33 districts, each of which is in charge of a superintendent. The four leading elements considered in rating the work of these district superintendents in maintaining the county highways are: No. 1, grading, dragging, 25 per cent; No. 2, condition of crown and berme of road, 25 per cent; No. 3, condition of ditches, drainage, 25 per cent; No. 4, management of district, 25 per cent. The county superintendent drives over the district every [illegible] and decides on the proper percentage [illegible] each of the above elements. The grades are published every month.



DISTRICTS

1. W H Hood
2 Henry Kroerner
3. Joseph Gill
4. August Sephel
5 Edwin Koone
6. Wm. Thompson
7 John T Fackler
8. Stuart Brown
9 Morton Hoose
10. Daniel Nall
11. Grant Ginther
12 Henry Young
13. Gerry Kees
14 Frank Webb
15. Thomas Ott
16 Ralph Springer
17. Joseph German
18 Otto Meyer
19 Sherm Townsend
20 Bert Luther
21 Wm. Schlaudroff
22 Wm. Werling
23. James Rose
24 Thomas Mullen
25. Wesley Smith
26 Joseph Toder
27. Alfred Corbin
28. W B Cole
29 August Romery
30 Frank Byers
31 John Duff
32 Floyd Irving
33 Christ Heckler

Grading of
Road Superintendents
of Allen County, Indiana

The four leading elements considered in maintaining County Highways are:

No. 1. Grading, Dragging 25%

No. 2. Grown and Bermes of Road - - 25%

No. 3. Ditches, Drainage 25%

No. 4. Management of District - - 25%

100%

1

2

3

4

TOTAL

WILLIAM G. TONREL
Allen County Highway
Superintendent

HENRY HILGEMANN,
ALEXANDER J BAKER
FRANK POIRSON,
County Commissioners

HARRY O. HOGAN
County Attorney

ASA W. GROSVENOR
Surveyor

A. C. McCOY,
Auditor

Date 19

District No.

Supt

Graded by

Remarks

Blank Used in Grading Work of District Road Superintendents.

3,450 Miles of Federal Aid Under Construction on May 1.—The remarkable rate at which the number of Federal-aid road construction projects had increased [illegible] is shown in a summary covering the progress of work from Sept. 30, 1916, to April 30, 1920, which has been prepared by the Bureau of Public Roads, United States Department of Agriculture. On the latter date the states had filed with the Bureau 2,885 project statements, of which [illegible] had been approved, representing [illegible] miles of highway. The [illegible] 1919, were little more than one-third these amounts. [illegible] to May 1 of this year 1,974 projects had proceeded to the stage at which plans, specifications, and estimates had been delivered to the Bureau of Public Roads. The plans, specifications, and estimates of 1,827 of these had been recommended for approval, representing 13,845 miles. Project agreements had actually been executed and construction work was in progress on 1,569 projects, totaling 11,987 miles. In addition, work had been begun on about 100 projects for which agreements had not actually been signed, thus expediting the progress of the work and bringing the total mileage under construction up to 13,540. The summary shows that a great reduction has been made in the time required for preliminary work before actual construction is begun. On the average the states have submitted project statements for nearly 95 per cent of their respective allotments and have entered into agreement to construct highways which call for about one-half of their Federal-aid money. The projects actually completed and paid for are comparatively few, but they are materially exceeded in number by those which are practically completed. California, Delaware, Illinois, Idaho, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Minnesota Nebraska, New Hampshire, New Jersey, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Utah, Washington, West Virginia and Wyoming have each submitted approved project statements for all or nearly all of their allotments.

Engineering Societies Asked to Endorse Classification and to Discuss Compensation Proposed by Engineering Council Committee

The Classification and Compensation Committee of Engineering Council over the signatures of Arthur S. Tuttle, Chairman, and Charles Whiting Baker, Secretary, on June 9 addressed a letter to the secretaries of each of approximately 100 national or local engineering and other technical societies, asking formal endorsement by the governing body or by the society as a whole of the classification adopted by Engineering Council to the end that it may become generally recognized and put into effect. As to the suitability of the scale of compensation and the employment policy tentatively suggested, the committee desires an expression of views both of the societies and of individual members thereof.

Through the medium of their society publications or some other convenient means, the secretaries are requested to urge the members to report to the committee any action taken to increase compensation or to adopt the standard classification. The committee proposes to act as a clearing house for receiving and giving out such information to any group of engineers for use in discussing these matters with authorities who have the responsibility for fixing compensation. "Through co-operative action," the committee states, "the effectiveness of the work done toward increasing compensation can be materially advanced."

To date several societies have taken action in regard to this matter. The Municipal Engineers of the city of New York on May 26, 1920, endorsed the classification and adopted a schedule providing for compensation at a rate of approximately 20 per cent greater than that tentatively suggested by Engineering Council's Committee. The classification has been closely followed by the Congressional Joint Commission on Reclassification of Salaries in its recommendations concerning engineers in the Federal service. It was approved on April 13, 1920, by the executive committee of the American Society for Testing Material. The Boston Society of Civil Engineers made the endorsement of the tentative schedule of compensation the subject of a letter ballot by the full membership, which is now being canvassed.

The committee has been reorganized and is now made up as follows: Arthur S. Tuttle, Chairman, Deputy Chief Engineer, Board of Estimate and Apportionment, 1347 Municipal Bldg., New York; Charles Whiting Baker, Secretary, Consulting Engineer, 31 Nassau St., New York; Frederick W. Cappelen, City Engineer, City Hall, Minneapolis, Minn.; Philip P. Farley, Consulting Engineer, Borough Hall, Brooklyn, N. Y.; O. C. Merrill, Chief Engineer, Forest Service, Washington, D. C.; C. A. Morse, Chief Engineer, C. R. I. & P. R. R., La Salle St. Station, Chicago, Ill.; M. M. O'Shaughnessy, City Engineer, City Hall, San Francisco, Cal.; R. S. Parsons, General Manager, Erie R. R., 50 Church St., New York; and Edmund L. Mitchell, Assistant Secretary, 29 W. 39th St., New York.

Present Status Federal Aid Funds for Road Construction

When the Congress of the United States made the first appropriation for Federal Aid, one of the provisions enacted was that the funds appropriated for any given fiscal year must be taken up within that fiscal year or the next one succeeding. It therefore transpires that about every year the question is raised as to whether all of the funds that have been made available have been absorbed by the states. During previous years this question has been of comparatively little importance because the amount of Federal Aid was relatively small and the probability of any state failing to take up its share, remote. However, when Congress added to the original appropriation the sum of $200,000,000 of which $50,000,000 was made available for the fiscal year 1919, and therefore had to be taken up prior to July 1, 1920, a real test of the ability of the states to absorb Federal Aid funds was established. It is therefore not without significance that the States have taken up these funds more promptly than the smaller sums available during any previous year and that on June 16, the Chief Engineer of the Bureau of Public Roads signed the last plans and estimates needed in order to absorb the full allotment for the last State in the Union.

TABLE 1—STATUS OF FEDERAL AID FUNDS ON JUNE 16, 1920

States	Funds which must be taken up prior to July 1, 1920.	Funds obligated by plans and estimates approved by Chief Engineer of the Bureau of Public Roads.	Funds which must be taken up prior to July 1, 1921.	[illegible] which remains of funds to be taken up prior to July 1, 1921.
Alabama	$1,676,167	$1,714,967	$6,671,669	$1,[illegible]
Arizona	959,097	970,074	2,397,707	1,3[illegible]
Arkansas	1,338,315	1,301,127	2,921,751	[illegible]
California	2,437,607	3,060,552	5,329,679	2,[illegible]
Colorado	1,375,920	1,450,904	3,024,504	1,[illegible]
Connecticut	492,552	981,823	1,075,975	[illegible]
Delaware	130,349	284,980	284,980	
Florida	912,449	1,476,917	2,002,664	[illegible]
Georgia	2,152,942	4,067,844	4,710,427	[illegible]
Idaho	974,371	1,003,107	2,134,338	1,131,2[illegible]
Illinois	[illegible],506,652	10,484,154	7,659,199	
Indiana	2,163,392	2,330,279	4,728,239	[illegible]
Iowa	2,316,226	5,318,649	5,058,011	
Kansas	2,295,068	4,888,460	5,024,064	1[illegible]
Kentucky	1,562,265	1,614,538	3,418,309	1,802,771
Louisiana	1,086,968	1,918,464	2,380,293	461,828
Maine	771,393	1,056,827	1,685,733	628,905
Maryland	697,750	1,691,116	1,523,750	....
Massachusetts	1,179,698	1,600,470	2,579,776	979,30[illegible]
Michigan	2,319,921	3,309,422	5,069,627	1,760,2[illegible]
Minnesota	2,273,822	3,662,728	4,973,293	1,310,565
Mississippi	1,414,957	1,590,182	3,143,985	1,553,802
Missouri	2,714,079	[illegible],049,693	5,931,176	2,885,082
Montana	1,792,849	1,508,854	3,491,837	1,98[illegible]
Nebraska	1,706,[illegible]	3,451,947	3,733,019	281,071
Nevada	1,0[illegible]358	1,081,665	2,250,931	1,169,[illegible]
New Hampshire	333,410	790,690	728,250	....
New Jersey	949,046	1,454,849	2,077,742	622,8[illegible]
New Mexico	1,273,633	1,307,676	2,791,326	1,483,[illegible]
New York	3,989,791	4,213,480	8,716,908	1,503,428
North Carolina	1,825,679	3,127,560	3,991,636	864,076
North Dakota	1,226,375	1,256,560	2,686,259	1,429,698
Ohio	2,973,222	5,446,803	6,496,700	1,04[illegible]
Oklahoma	1,841,961	1,889,799	4,035,767	2,14[illegible]
Oregon	1,259,853	3,320,163	2,756,026	
Pennsylvania	3,678,154	9,624,353	8,040,698	
Rhode Island	186,500	403,834	407,909	1,074
South Carolina	1,147,734	1,538,526	2,510,598	[illegible]2,071
South Dakota	1,134,842	1,155,215	2,837,103	1,681,8[illegible]
Tennessee	1,815,227	2,683,106	3,966,224	1,[illegible]2,818
Texas	1,095,133	4,162,884	10,238,8[illegible]	[illegible]
Utah	909,205	985,775	1,987,6[illegible]	1,001,855
Vermont	362,650	476,240	792,026	315,7[illegible]
Virginia	1,789,155	2,250,1[illegible]	3,471,056	[illegible]
Washington	1,154,550	3,565,604	2,527,018	
West Virginia	851,534	2,008,[illegible]40	1,8[illegible]	
Wisconsin	2,640,736	2,208,988	4,459,[illegible]	250,[illegible]
Wyoming	960,308	1,147,678	2,111,842	697,16[illegible]

Table 1, which shows the amount of Federal Aid funds so far covered by plans and estimates, is also of interest because it shows that, not only has all of the Federal Aid which had to be covered prior to July 1, been covered, but that a very large part of the 1920 funds have also been covered. Indeed, this table shows that eight of the States have taken up all of the funds available prior for July 1 and that seven of these have obligated a portion of the funds that do not become available until after the first of July.

Some impression of the rate at which Federal Aid is being requested may be secured from the following: During April new projects were submitted which called for Federal Aid amounting to $9,779,857, and plans and estimates were approved that called for $[illegible] of Federal Aid. In May new projects were presented for approval that called for $[illegible],719,8[illegible] of Federal Aid and plans and estimates were submitted on previously approved projects which required $[illegible],[illegible]56,872 of Federal Aid. During the first half of June new projects were submitted asking Federal Aid to the amount of $[illegible],777,701 and plans and specifications were approved by the Chief Engineer calling for Federal Aid to the amount of $7,8[illegible]2,630.

This volume of business, amounting at times to the handling of requests for Federal Aid that amounted to more than $1,000,000 a day, has been transacted by the office of the Chief Engineer without the slightest delay and without omitting in any case, the necessary examination and correction of plans. A still better conception of the work of the Bureau of Public Roads and of the organization which has now been developed can perhaps be had from the fact that while this work was being looked after the Bureau was also giving attention to the construction of more than 1,800 projects involving the building of some 18,000 miles of improved highway.

Proposed Specification for Sand-Clay Mixtures for Highway Surfacing

The Committee on Road Materials of the American Society for Testing Materials presented at the recent annual meeting of the society a specification for natural or artificial sand-clay mixtures for highway surfacing. The specification, which was submitted as tentative only, covers sand-clay and mixtures of sand-clay and gravel containing not more than 50 per cent of material over ¼ in. in size. The character and grading of the material are described as follows in the specification:

The sand-clay shall be composed of either a naturally occurring or artificially prepared mixture of hard, durable, preferably angular, fragments of sand, together with silt and clay with or without gravel, and shall be free from an excess of feldspar or mica.

(a) When tested by means of laboratory sieves and screens the sand-clay or gravel shall meet the following requirements for grading:

(b) The material, if any, retained on a ¼-in. screen shall be uniformly graded from the maximum size present to ¼ in.

(c) The material passing a ¼-in. screen shall meet the following requirements:

	Per cent
Total sand	50 to 80
Sand over 60-mesh[1]	25 to 50
Silt	5 to 20
Clay	15 to 30

[1] For specifications for this sieve, see Standard Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregates Used in Cement Concrete (D7), 1918 Book of A. S. T. M. Standards, p. 663.

Index Numbers of Wholesale Prices in United States in May, 1920.—Below are shown the index numbers of wholesale prices in the United States, by groups of commodities, as computed by the U. S. Bureau of Labor Statistics. The figures for May are preliminary and subject to revision. The base used in computing these index numbers is the average for the calendar year 1913:

INDEX NUMBERS OF WHOLESALE PRICES, BY GROUPS OF COMMODITIES

(1913 equals 100.)

Group.	May, 1920.
Farm products	244
Food, etc.	287
Cloths and clothing	347
Fuel and lighting	235
Metal and metal products	193
Lumber and building materials	341
Chemicals and drugs	215
House-furnishing goods	339
Miscellaneous	246
All commodities	272

As measured by changes in the index numbers for the 12 months from May, 1919, to May, 1920, farm products increased 1.7 per cent in price, food 34 per cent, and cloths and clothing 52.2 per cent. During the same time fuel and lighting increased 40.7 per cent, metals and metal products 27 per cent, and lumber and building materials 107.9 per cent in price. Chemicals and drugs increased 20.1 per cent, house-furnishing goods 56.2 per cent, and miscellaneous commodities 15.5 per cent in average price. All commodities, considered in the aggregate, increased 31.4 per cent in price.

Interstate Commerce Commission Needs Engineers.—The [illegible] that the In[illegible] effort to ex[illegible] The importance [illegible] evident [illegible] of the law which [illegible] of transportation properties to pri[illegible] Interstate Com[illegible] adjust rates so as to insure a fair [illegible] value of the railway property of [illegible] the valuation made by the Com[illegible] that the office technical force of the [illegible] engaged in the computation and assembly [illegible] data furnished by the field engineers. [illegible] Commission needs architects and [illegible] electrical, structural, signal, [illegible] Senior architects and engineers [illegible] salaries from $2,100 to $2,700 a year; [illegible] to $1,920, junior architects, $1,320 to [illegible] and chainmen at $720 to $1,080 will also [illegible] field and office forces. Employes are [illegible] for subsistence, as well as transpor[illegible] away on official business, and are [illegible] the increase of $20 a month granted by Con[illegible] Civil Service Commission will receive applica[illegible] positions until further notice.

Chinese to Build Roads in Shantung Province.—A plan is [illegible] within Shantung a system of highways [illegible] automobile truck service in connecting all [illegible] It also is proposed to deepen and im[illegible] that these roads and streams will afford [illegible] of the province a transportation sys[illegible] will place them on an equal footing with [illegible] now control channels of communication. [illegible] T'and Enliand, a graduate of Purdue [illegible] made director of the newly created [illegible] Waterways in Shantung, active survey[illegible] connection with the project has been started out [illegible] and present plans contemplate the building of 1,600 [illegible] and the deepening of the Hsiah Ch'lng [illegible] is to weave all important cities of the [illegible] unified transportation system. A scheme of [illegible] out the big project by which the funds to [illegible] will be supplied in part by merchants, land [illegible] to be benefited and in part by the provin[illegible] according to official announcement, has re[illegible] endorsement throughout the province.

Cost of Grading Dirt Roads with Tractor and Grader.—[illegible] in Elk County, Kansas, is being done this [illegible] owned tractor-grader outfit at a cost of [illegible] The tractor, a 10-80, cost $1,000, and [illegible] cost $900. The roads are built to an aver[illegible] and 1 to 1 slopes. The outfit [illegible] to 1 mile in an 8-hour day, the mileage [illegible] The cost of the work is as [illegible]

	Per 8-hr. day.
[illegible]	$12.00
[illegible]	10.00
[illegible]	3.00
Total	$25.00

[illegible] County Engineer.

Engineering Society to Assist in Geological Study.—Upon [illegible] W. B. D[illegible] of the Oregon [illegible] Commission, the American [illegible] Oregon Chapter, has appointed a [illegible] study of the [illegible] in publishing [illegible] of the [illegible] Chapter [illegible] of Port[illegible]

Obituaries

[illegible] June

[illegible] June

[illegible] Park [illegible] ing- [illegible] and [illegible] park

Personals

H. D. Chapman has been appointed city engineer and superintendent of streets of Richmond, Calif.

R. E. Royall has been appointed associate professor of highway engineering in Washington and Lee University.

Oscar F. Bellows of Newark, N. J., has been appointed assistant engineer of the New York and New Jersey Bridge and Tunnel Commission.

Col. John F. Stevens has been decorated by the Chinese Government in recognition of his services as head of the Interallied Technical Board.

M. C. Polk, for the past 17 years County Road Engineer or County Surveyor of Butte County, Calif., has resigned and will engage in private practice.

Geo. K. Ames has resigned as assistant engineer and office engineer of the Florida State Road Department, and will engage in private practice with office at Tallahassee, Fla.

Joseph McCarty, H. Killian, L. McCarty and G. J. Flanagan have organized the Joseph McCarty Construction Co. of Kaukauna, Wis., and will engage in paving and reinforced concrete work.

Harry G. Perring, who has been the resident engineer in charge of the Capitol Park extension improvements (Harrisburg, Pa.), has resigned to become a member of the city engineer's staff of Baltimore.

A. Burton Cohen has resigned as concrete engineer for Delaware, Lackawanna & Western R. R. to enter private practice as consulting engineer, with offices at 1 Madison Ave., New York City. He will specialze in reinforced concrete design and construction bridges, buildings and railroad structures.

Prof. A. A. Potter has been appointed dean of engineering at Purdue University. He is a graduate of the Massachusetts Institute of Technology. At present he is consulting engineer for the Kansas board of administration in connection with the purchase of engineering materials for all state institutions.

E. P. Neuschwander, assistant engineer on construction of New York state barge canal, has been appointed assistant engineer in the designing department of the New York Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission, with office in the Hall of Records, New York City.

Arthur E. Loder, general inspector of the U. S. Bureau of Public Roads, with headquarters at Washington, D. C., has been appointed District Engineer for the Bureau, with headquarters at Montgomery, Ala., to have charge of the southeastern district, comprising the states of South Carolina, Georgia, Florida, Alabama, Mississippi and Tennessee.

John Emprie, resident engineer on the construction of the Ottawa-Prescott Highway, with headquarters at Kemptville, Ont., leaves shortly for Western Ontario, where he will assume similar duties on the London-Sarnia section of the Provincial Highway. He is succeeded at Kemptville by Lt.-Col Earchman, who commanded a construction battalion in France.

Roy M. Green, professor of highway engineering at the Agricultural and Mechanical College of Texas, has resigned his position with the college in order to become president and manager of the Western Laboratories at Lincoln, Neb. Western Laboratories will take over the consulting and testing practice of Clark E. Mickey of Lincoln, Neb., and will specialize in the testing and inspection of all kinds of building materials and operations.

Doctor F. H. Newell, head of the department of civil engineering at the University of Illinois and past president of A. A. E., will serve as director of field forces of the American Association of Engineers during the summer months. Doctor Newell will spend a large proportion of his time in traveling and will assist the chapters in solving their problems of organization and expansion and assist them to prepare for rendering greater service

William G. Thompson has resigned as state highway engineer of New Jersey, to engage in private practice. Mr. Watson G. Clark, of Tenafly, a former member of the State Highway Commission, has been temporarily appointed consulting engineer with full power of state highway engineer. Mr. Thompson was on the engineering and construction staff of the Panama Canal from 1905 to 1910. From April, 1917, to April, 1918, he was assistant state highway engineer of New Jersey and on April 1, 1918, was appointed to his present berth on recommendation of State Engineer Goethals. Mr. Clark is an engineer with offices at Tenafly and Edgewater and in New York City.

David Young, John Ferris, George Paddock, Walter F. Whittemore, George L. Burton, William J. Kirby and Thomas E. Collins have been appointed members of the new State Highway Commission of New Jersey. Mr. Young is an engineer and a former vice-president and general manager of the old North Jersey Street Railway Co., now a part of the Public Service Railway Co. He now devotes most of his time to farming. Mr. Farris is a member of the firm of Stillman, Delahanty & Ferris, contractors. Mr Paddock is president of the Paddock-Zusi Motor Co., of Newark. Mr. Whittemore is an engineer and was engaged in supervising the construction of the North German Lloyd piers at Hoboken. Mr. Burton is a lawyer and was a member of the Assembly in 1913 and 1911. Mr. Kirby is an iron manufacturer. Mr. Collins is city engineer of Elizabeth

Industrial Notes

Chain Belt Co., Milwaukee, Wis., announces the appointment of the Clifford Waterhouse Company of Jackson, Miss., as exclusive agents for Rex Concrete Mixers and Pavers in Central Mississippi, a territory which has recently been opened.

Dewitt Clinton Grove, past vice president of the Technical Publicity Association, has become advertising manager of the Blaw-Knox Co., of Pittsburgh. Mr. Grove succeeds George Land, who resigned July 1st to enter the agency field as head of the Technical Publicity Co., of Pittsburgh. Mr Grove came to the Blaw-Knox Company from the H. S. Cameron Pump Co., a subsidiary of the Ingersoll-Rand Co., where he was in charge of the advertising department. Previous to that, he handled the advertising of mining machinery and other equipment for the Ingersoll-Rand Co. For eight years before this he was advertising manager of the Deihl Manufacturing Co., of Elizabethport. He was chairman of the executive committee of the Elizabeth Advertising Club. Another new man in the Blaw-Knox advertising department is Leo Rolén, a former newspaper editor of Pittsburgh, who in connection with other duties is editing "Blaw-Knox Life," the company's house organ.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies
- (e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power and Pumping
- (e) Management and Office System

Railways and Excavation—3rd Wednesday
- (a) Excavation
- (b) Management and Office System
- (c) Quarries and Pits
- (d) Steam Railways, Construction and Maintenance
- (e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Harbor Structures
- (d) Miscellaneous Structures
- (e) Properties of Materials
- (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Volume LIV CHICAGO, ILL., JULY 14, 1920. Number 2.

A Public Servant Who Has Added Millions to National Wealth Yet Receives Only $250 a Month

Capitalism produces inequalities in individual income that are often unjust. But the leveling of incomes under socialistic government, if not actually unjust, may at least be uneconomic, for the absence of prizes for meritorious achievement certainly retards economic progress. All governments are in some measure socialistic. Rarely does any government reward its best brain workers in a manner comparable with the rewards securable in private life. The result is decreased inventiveness. To such an extent is ingenuity suppressed by lack of governmental rewards that it is a common saying that no public employe has ever produced a noteworthy invention. While this is an exaggeration, nevertheless it is sufficiently close to the truth to cause no surprise when we do occasionally read of some really important improvement made by a public servant.

The Literary Digest recently told of the development of a remarkable variety of wheat by Dr. Charles E. Saunders, of Canada. His father had begun experimental cross breeding of wheat in 1888, and by 1901 had produced 58 new varieties. In 1903 the son, Dr. Charles E. Saunders, took up the task where the father and brother had ended, and in 1904 produced the long sought variety which is called Marquis. About three-fourths of the wheat now grown in Minnesota and North Dakota is Marquis, and it is widely grown in Canada. "Its supreme merit is its capacity for quick maturity, its growing period averaging only 115 days, thus enabling it to escape droughts and early frosts.

Marquis or a derivative thereof has won the international prize as the best spring wheat for seven successive years. Every year the volume of its crop shows a huge increase, and it is a question whether nature has ever before been able to parallel the example of vegetable fecundity shown in the millions of Marquis wheat plants which ripened last autumn on this continent, and, be it remembered, all derived their origin from a single grain of wheat planted at Ottawa as recently as 1903. Yet when Dr. Saunders was making the tests which led to the discovery of Marquis he was enjoying the princely salary of $100 per month, and today when his labors have enriched this continent by millions, an economical government does not pay him more than $3,000 per annum. He has been infinitely more valuable to Canada than any two score of her politicians, but the general public is almost unaware of his existence."

The last paragraph is quoted from a paper by Prof. A. H. R. Buller, of the University of Manitoba. Had it been possible for Dr. Saunders to patent his "invention" of this remarkable variety of wheat, he could have made a great fortune even were his royalties but a small percentage of the total resulting economic gain. The injustice of the public is such that he probably never will be adequately compensated for his great achievement. But entirely apart from such injustice is the economic foolishness of so conducting our governments that superior intelligence must seek employment in private affairs if it is to receive proper reward.

One of the fundamental laws of scientific management is the payment of services in proportion to performance. Failure to observe this law is at the bottom of most of the prevailing inefficiency. Occasionally a public employe like Dr. Saunders produces results that seem to negative the truth of this law of management, but it should be remembered that for every such man who will devote his entire energy and ability to public service regardless of recompense there are a hundred who will not.

The Defective Water-Power Law

At last the long discussed water-power bill has become a law. We fear, however, that such great care has been taken to "protect the public against the corporations" that many corporations will protect themselves by not risking their money in water-power developments. The new law provides that only a "fair return" shall be earned upon the actual investment in a power project, but it fails to guarantee that there shall be a "fair return." In short, it is "heads I win, tails you lose" sort of a proposition. There are, therefore, only two conditions under which a corpora-

[illegible] [illegible] [illegible] [illegible] [illegible] of the opportunity to develop water-power controlled by the government: First, where the [illegible] [illegible] are practically nil. Second, where the use of the power is a relatively small source of [illegible], the [illegible] [illegible] being the sale of some product of [illegible] [illegible] [illegible].

It is noteworthy that the few heads of corporations who have [illegible] [illegible] any approval of the new law are in [illegible] of companies who fall under one or the other of the two [illegible] just named. For example, Henry J. Pierce, president of the Columbia Valley Reclamation Co. [illegible] [illegible] approvingly of the new law, in Electrical World [illegible] [illegible]. But Mr. Pierce's company owns 100,000 acres of arid land which it is proposed to irrigate by pumping with hydro-electric power. Obviously, such a company will be pleased with the new law, since its profit from [illegible] the land should be so great as to make it a matter of small moment what are its rates for by-product use of electricity.

[illegible] there will be many other companies similarly [illegible] to take advantage of the opportunity to develop water-power where they can use most of the power themselves for farming, for railroading, for mining or for manufacturing. But such companies will be in the minority, compared with those that sell all their power. It is these latter companies that will hesitate about putting any more capital into plants whose maximum net earnings are to be [illegible] [illegible] to the commonly allowed 6 to 8 per cent for return, while their minimum net earnings may be less than nothing at all. All in all this new water-power law contains [illegible] enough to enthuse about and plenty enough to re-[illegible].

Civil Engineers as Political Economists

The scientific manager of governmental affairs is at present conspicuous by his rarity. Professional political economists seldom hold public office, their main occupation being the teaching of college students. But here and there a civil engineer has become a city manager, a superintendent of public works, or even a state governor, and wherever this has occurred there has been an attempt to introduce scientific methods.

Other than engineers there is no large class of scientifically trained men who are at all likely to enter the political arena. And among engineers none are so apt to secure political positions of an executive nature as are civil engineers. We believe, therefore, that the majority of practical political economists—trained scientists in charge of governmental administration—will ultimately come from the ranks of civil engineering.

The term political economist at present calls to mind [illegible] the professor of economics, a type of person who unfortunately has ordinarily had very little training in applied economics of any sort. The books written by such "economists" are long on doctrines and short on data, strong on theory and weak on practice. Their theories, moreover, are often questionable because of their failure to reduce them to terms susceptible of verification.

The average political economist delights in a formula not one of whose terms has a definite quantitative value assigned to it. What cares he for the data so long as the doctrine appears to be irrefutable? His is not the task of applying a theory but merely of deducing it. And as usually happens in such cases, his theories are seldom complete and are not infrequently wrong in their entirety.

We urge upon civil engineers the critical study of the works of political economists, not merely with a view to understanding their terms and theories, but with the purpose of ultimately putting the science of political economics upon a sounder basis. The entire science of valuation and public utility rate making has been the product of civil and [illegible] engineers, not a single development of it being attributable to professed political economists; yet this science is not regarded as a branch of political economics. The science of cost analysis and cost keeping also owes its main development to engineers, as Hatfield (himself not an engineer) concedes in his "Modern Accounting." Yet cost analysis and cost keeping are essential to any form of [illegible] [illegible] management, be it industrial or political. The science of "management," a term coined by a civil engineer, was not only an engineer's conception, but almost its entire development is attributable to engineers. Certainly the literature of the subject would be bald indeed were it shaven of the writings of engineers.

If a great many engineers will now broaden their economic studies, applying engineering methods to every branch of political economics as they are now applying them to industrial or business economics, ten years will not elapse before there will exist a really practical and sound science of political economy.

A Million Dollar Dam That Does Not Hold Water

Several years ago a dam was built at Cedar Falls, Wash., to impound water for power purposes. The dam was not carried to bed rock, and, as had been predicted by experienced engineers, it failed to hold water. The city of Seattle, for whose municipal electric plant this dam had been constructed, then undertook to try to seal the bed of the valley for some distance above the dam, by sluicing clay into the basin. Now it is announced by J. D. Rose, the superintendent of the municipal electric plant, that the expenditure of $400,000 in the attempt to stop the leakage with clay has been futile, and that the million dollar dam must be abandoned.

We venture to predict that the loss of this huge sum of money will never be charged to the depreciation reserve of the municipal electric plant. We understand that several years before Seattle undertook to build this dam, a private power company had investigated its site and had decided that a safe, watertight reservoir could not be built there except at a cost that would be profitable. Would it not be well for the engineers of Seattle to investigate the responsibility for this fiasco. The money that is lost can not be recovered, but perhaps the city can be protected against similar blunders in the future.

Book Review

Engineering for Land Drainage. A Manual for the Reclamation of Lands Injured by Water.—By Charles Gleason Elliott, C. E., M. Am. Soc. C. E., Consulting Drainage Engineer, Formerly Chief of Drainage Investigations U. S. Department of Agriculture. Third Edition, Revised. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. 363; illustrated. $2.50 net.

Since the first edition in 1902 and the second in 1911, the present third edition has been largely rewritten and brought up to date.

Something of romance is added to the field of drainage engineering in the introductory and historical chapters. The prosaic requisites of an ordinary surveyor will not necessarily qualify him as a drainage engineer, but the qualifications of the latter should, nevertheless, include those of the former.

Methods for making a preliminary survey for a drainage project are simply and explicitly described. The two principle methods of land drainage, underdrains and open ditch, receive considerable attention. Under the first are discussed the different systems, frequency of drains, depth, etc. A chapter on flow in underdrains has been rewritten for this edition to conform to recent experimental data. The author advances formulas for the solution of this problem. The run-off from underdrained areas is at best a variable factor, but with the data presented, it is possible to exercise good judgment and reduce errors. The size of tile drains required is solvable by the author's formulas, although the economical and efficient size are a matter of engineering judgment. The proper selection and construction of an underdrainage system are discussed and many interesting and exact details are given.

Drainage with open ditches naturally involves larger areas. Run-off from large areas is always a problem for study but the author has discussed this well and laid particular emphasis on the selection of a drainage coefficient. Practical methods for the location and construction include such things as proper dimensions, right of way, inlets, curvature, effect of weirs and other obstructions, and even camping outfits.

A chapter devoted to the formation and operation of drainage districts discusses the legal phases such as assessments for benefit and damages.

Some of the features rewritten for this edition are the operation of drainage pumps and the drainage of irrigated lands. The drainage of peat and muck lands, the reclamation of tidal swamps, and the drainage of home surroundings complete the principle topics treated.

The volume is particularly commendable in the amount of detail it goes into and the simplicity of the language. The author calls it a manual and such is its best description.

Cost of Operation of Small Municipal Light and Water Plant

The following detailed costs of operation of the municipal light and water plant at Russell, Kans., are interesting in that it is unusual to find such good records in towns of this size. Jas. H. Bradley, superintendent power plant, Russell, Kans., contributed the data in the May issue of Kansas Municipalities.

The approximate valuation of the city light plant of Russell, independent of the water department, is $[illegible],000. The operating expense of the light plant for 1919 is itemized in the following order:

Fuel oil	[illegible]
Waste	[illegible]
Misc. supplies and expenses	[illegible]
Wages	[illegible]
Lubricating oil	[illegible]
Maintenance	[illegible]
Total	$[illegible]
Overhead	
Depreciation	[illegible]
Interest on $[illegible],000 at [illegible] per cent	1,110.00
Insurance	118.[illegible]
Total	$[illegible]
Total cost of electricity on switchboard for 1919	$12,855.16

The production record by months for 1919 is as follows:

January	22,8[illegible]0 kw-hrs.
February	18,477 kw-hrs.
March	2[illegible],792 kw-hrs.
April	22,[illegible]76 kw-hrs.
May	21,773 kw-hrs.
June	21,610 kw-hrs.
July	36,906 kw-hrs.
August	38,852 kw-hrs.
September	31,[illegible]59 kw-hrs.
October	28,292 kw-hrs.
November	24,993 kw-hrs.
December	25,956 kw-hrs.
Total	325,856 kw-hrs.

By dividing the total cost, $12,855.16, by the total production, we find that the electric energy cost us a flat rate of 3.945 ct. per kw-hr. on the switch board.

Allowing for a 25 per cent line loss, which would be a fair average, the electric energy cost us 5.26 ct. delivered to the consumer.

The present schedule of rates for electric light is:

First 20 kw-hrs. at	10c per kw-hr.
Next 40 kw-hrs. at	9c per kw-hr.
All over 60 kw-hrs. at	8c per kw-hr.
Minimum	$1.[illegible]

The present schedule of rates for electric power and heat is:

First 500 kw-hrs. at	5c per kw-hr.
Next 1000 kw-hrs. at	4c per kw-hr.
All over 1500 kw-hrs. at	[illegible]c per kw-hr.
Minimum	[illegible]

Data on water pumped previous to May 1, 1919, was not available, but the following are the records on water pumped beginning with May 1, 1919:

	Gallons	Cost per 1000 Gal.
May	1,473,900	[illegible]
June	1,296,365	[illegible]
July	1,683,317	[illegible]
August	3,100,320	[illegible]
September	1,983,161	[illegible]
October	1,290,760	[illegible]
November	1,759,000	[illegible]
December	1,679,150	[illegible]
Total	11,566,00[illegible]	

Average cost per thousand gallons [illegible]

The present schedule of rates charged for water is:

Minimum	$1.00 for 4000 gal.
Up to 30,000 gal.	25 ct. per 1000 gal.
All over 30,000 gal.	20 ct. per 1000 gal.
100,000 gal. or more	Special rates

Our water system is 100 per cent metered. The meters are owned, installed and maintained by the consumer.

Cost of Niter Cake.—Our attention has been called to an error in the article on page 651 of our June 9 issue on the use of niter cakes as a mosquito larvicide. In the article it was stated that niter cake cost $85 per ton. The price should have been $5 per ton.

Price as Determined by the Law of Supply and Demand

By HALBERT P. GILLETTE, Editor

In the Encyclopedia Britannica under Value, Prof. Joseph S. Nicholson gives the following statement of the law of supply and demand:

> In any market the price of any article will be so adjusted that the quantity demanded will exactly equal the quantity offered at that price. * * * The law as thus stated corresponds to what Mill calls the equation between demand and supply.

But, as thus stated, this so-called law is merely a truism. The mechanical law that action and reaction are equal and in opposite directions is not only not self-evident but is of great practical utility. What corresponding utility exists in the "law" of supply and demand above given? None whatever that was not already in the possession of any intelligent man, or, for the matter of that, of any semi-intelligent youth.

In his Principles of Political Economy John Stuart Mill devotes a chapter to supply and demand in their relation to value, yet at the end of the chapter the reader is no wiser than at the beginning. Indeed he is fortunate if he is not less wise, for Mill becomes badly confused in his attempt to show that value can not be a "ratio" between supply and demand, but must be an "equation." He says:

> Some confusion must always attach to a phrase so inappropriate as that of two things not of the same denomination. What ratio can there be between a quantity and a desire, or even a desire combined with a power? * * * Thus we see that the idea of a ratio, as between demand and supply, is out of place, and has no concern in the matter. The proper mathematical analogy is that of an equation. Demand and supply, the quantity demanded and the quantity supplied, will be made equal.

Reduced to algebraic formula Mill would have us write the law of supply and demand thus:

$$N = N$$

or perhaps

$$N = N$$

Either way the equation is fruitless.

Mill was a professional logician, but he was neither a mathematician nor a practical scientist. Had he been an engineer, he would have felt scant satisfaction in a "law" that professes to state the factors that determine price, yet is absolutely useless in arriving at a specific price under given conditions.

Mill has been followed by Prof. Taussig, of Harvard, and by other writers of works on "economics," and they all give us essentially the same fruitless "law" of supply and demand.

In the April 7 issue of this journal I attempted to deduce a formula for determining price levels, and in doing so I mentioned the possibly greater difficulty of deducing formulas for determining the prices of any given class of commodities. I will now outline an attack upon this latter problem.

If instead of regarding "demand" as being the quantity of any given class of commodity, we regard it as being measured by the number of dollars (D) used in the purchase of that commodity during a given period of time, we shall avoid the pit into which Mill fell. We can write a value equation that will have real meaning:

$$P = \frac{D}{S}$$

P = unit price.

D = demand as expressed in dollars paid.

S = supply as expressed in number of units sold.

Demand (D) and supply (S) are materially dependent variables. For example, if the supply increases, the demand usually increases also. I am speaking of "effectual demand," as Adam Smith calls the demand that is registered in actual purchases. Hence we may write the functional relationship between demand and supply thus:

$$D = f(S)$$

whence we have

$$P = \frac{f(S)}{S}$$

In this form the price equation may have great utility. Suppose, for example, that experience has demonstrated that for a given class of commodity the functional relationship between demand and supply is given by the curve in Fig. 1. Then we have simply to determine the equation of the curve, D = f(S), and insert the value of f(S) in the price formula, in order to be able to predict the price with considerable ac-

[illegible] supply of the given commodity.

[illegible] price formula, it is easy to determine what quantity of rental production (S) will yield a [illegible]

A Common Fallacy About the Significance of Formulas. A mathematical formula expresses a functional relationship [illegible] cause-effect relationship other than [illegible] conditions assumed in the process of [illegible] Yet it is noteworthy that many able [illegible] frequently commit the error of assuming that the factors in one member of an equation are the causes of the factors in the other member.

[illegible] the above given price formula in mind, consider the

Fig. 1—Relation of Supply to Demand.

[illegible] discussion in Taussig's "Principles of Economics":

[illegible] writers [illegible] that market value was settled by [illegible] of supply and demand. The everyday way of putting [illegible] that the value of a thing is determined by supply and demand. This statement is loose, since it implies [illegible] are causes that act independently, and [illegible] by price. But demand, in the sort [illegible] certainly affected by price. The lower the price [illegible] the more of it will be demanded, the higher the [illegible] less will be demanded. To say that price depends on [illegible] seems to be reasoning in a circle, since, if [illegible] by demand, demand is no less affected by price.

Observe that all of Prof. Taussig's trouble would vanish were he not regarding the factors (D and S) in the second member of the above given price equation as causes of the first member (P) of the equation. In deducing this equation the only condition assumed is this: The total money paid [illegible] registers the demand) must equal the total value (P × S) of all the goods sold. No cause-effect condition is [illegible] in this premise, although obviously the purchase and [illegible] a cause-effect phenomenon, as indeed all phenomena are.

This equation expresses a functional relationship between [illegible] and of itself announces nothing as to their cause-effect relationship; nor is the latter involved in any condition essential to the deduction of the relationship.

The square on the hypothenuse of a right-angled triangle equals the sum of the squares on the other two sides. Hence the square on the hypothenuse is "determined by" or "depends on" the other two sides. Does it follow therefore that the other two sides cause the hypothenuse? Or are they [illegible] by the hypothenuse? No, for this equation states [illegible] to a cause-effect sequence. It merely announces a functional relationship that is independent of any time element. This is so obvious that no one would find the slightest confusion in a statement that the square on the hypothenuse is determined by the other two sides. But let an equation be given expressing functional relationship between [illegible] and there arises an almost irresistible tendency to assume that the equation itself expresses their order in time and therefore their cause-effect relationship.

The price formula that I published in the Apr. 7 issue of Engineering and Contracting has been criticised on the ground that since population causes prices, prices could not vary inversely with population. By a parity of reasoning it might be argued that the old gravitational formula [illegible] must be incorrect since height is not caused by the attraction of gravitation.

Careful logician though he was, John Stuart Mill fell into the error of regarding a functional relationship as if it were a cause-effect relationship. Observe his confusion:

[illegible] partly depends on the value. But it was before [illegible] the value depends on the demand. From this [illegible] extremely [illegible] How solve the [illegible] of two things each depending upon the other?

There is no paradox about it at all, once it is realized that the expression "depends on" is not necessarily synonymous with "is caused by." The velocity that a falling body attains is dependent on the height through which it falls, but is not caused by that height.

Trend of Prices in Waterworks Construction and Operating Fields

In a paper presented at the last annual convention of the American Water Works' Association, held June 21-26 at Montreal, Mr Leonard Metcalf, of Metcalf & Eddy, Consulting Engineers, extended to Jan. 1, 1920, the data* submitted in 1918 and 1919 to the association upon the trend of prices in the waterworks field. His latest information was based upon the actual experiences of about 50 water works in various parts of the United State, having a gross annual revenue of about $34,000,000 and serving an aggregate population of upwards of 9,000,000. An abstract of the paper follows:

In Table I is shown a summary of the data upon increase in cost of unskilled labor and of materials used in the construction and operation of water works.

Labor and Material Costs. Unskilled labor costs continued their advance during the year 1919 and are yet higher to-day. The percentage of increase in cost per hour over pre-war (1915) prices averaged about 80 per cent—approximately 70 per cent in the western and central groups and 90 per cent in the eastern and southern. The average increase for the year 1919 over 1918 is about one-eighth. These results are shown diagrammatically in Fig. 1.

While the efficiency of labor is probably slightly better than during the war period, it is still far below pre-war standards. It is conservative to say that taking productivity into consideration, as well as the price paid per hour, the cost of unskilled labor is more than double its pre-war cost.

Cast iron pipe prices are today practically three times normal pre-war prices; the cost of valves and hydrants slightly less than double.

Coal prices have receded somewhat, more nearly approaching the conditions of 1917 than 1918.

Wages in Vicinity of Boston.—Table II gives comparative figures showing unskilled labor wages paid by water works in the vicinity of Boston, as of the end of March, 1920. Comparing them with the records of a year earlier the nominal increase in rate per hour has been from 43.2 ct. to 50.6 ct.; the actual increase, including allowance for holidays and vacation leave, from 46.1 ct. to 56.7 ct. per hour—21 per cent. Fourteen out of 20 departments grant holiday leave under full pay, and seventeen out of 20, two weeks' vacation annually under pay.

Revenue and Operating Expenses of Water Works.—In Figure 2 are shown the gross annual revenue, operating expenses including taxes, and the net annual revenue applicable to depreciation, interest, dividends and surplus, of 46 water works arranged in four groups covering the eastern, central, southern and western sections of the country. The per cent increase over the pre-war conditions—exemplified by those of the year 1915—are given, together with the average rate of increase applicable to the entire list.

Attention is called pointedly to the fact that these figures are shown in two ways, with and without the inclusion of the records of the cities of Detroit and Mingo Junction. The conditions there prevailing have been so very abnormal, it is believed, as to require the elimination of these records from consideration in deriving average figures.

From this record it appears that the gross annual revenue has increased in the years 1916 to 1919, inclusive, over pre-war conditions, progressively, by 8.5 per cent, 13.5 per cent, 22.7 per cent and 24.5 per cent. These amounts are all substantially below a normal rate of increase for such works.

The operating expenses, including taxes, have increased progressively over the pre-war basis by aproximately ⅛, ⅓, ½ and slightly over ½.

The net revenue, without deduction for and therefore applicable to depreciation, interest, dividends and surplus, has increased over the pre-war (1915) basis by 3.4 per cent, 0.4 per cent, 4 per cent and 8.5 per cent. This increase is less than half of what would be expected for such works in normal times. These figures indicate that in spite of the advances in rates, which have been granted in many places, the net revenue of the works is not adequate to command capital for their betterment over a long period of time. They indicate further, as will be seen from the diagram, that of the net burden resulting from war conditions about half has been borne by the works the other half by the public which they serve.

---

*See Engineering and Contracting, Aug. 14, 1918, and July 9, 1919.

A segregation of the records submitted as between municipally and privately owned works, indicates that the increase in gross revenue for both of these has been approximately the same, that the increase in expenses has been more than twice as great for the privately owned group as for the municipally owned, and that the net revenue of the privately owned group has practically stood still while the municipally owned group has been increased approximately 10 per cent. This comparison cannot be carried too far, however, as the list of municipally owned works is not sufficiently large to be thoroughly characteristic. Moreover, in the case of the municipally owned works the records of which are included a much greater proportion have gravity supplies than in the case of the privately owned group. This has served to minimize the increase in expenses which would otherwise have been felt. It may be that the decrease in available labor during the war period had a more material effect upon the municipal works than upon the private works and resulted in economies which would not have been possible in these public works under normal conditions. More important yet, it is to be observed that in the case of the municipal works substantially no taxes are paid, whereas in the privately owned group the taxes generally amount to about one eighth of the entire gross revenue, and these taxes, of course, have been burdensomely increased since the war burdens began to make themselves felt. This influence is the most important one of those responsible for the comparative results referred to. As previously stated, however, limited weight only can be given to these comparative results of operation by municipally and privately owned water works.

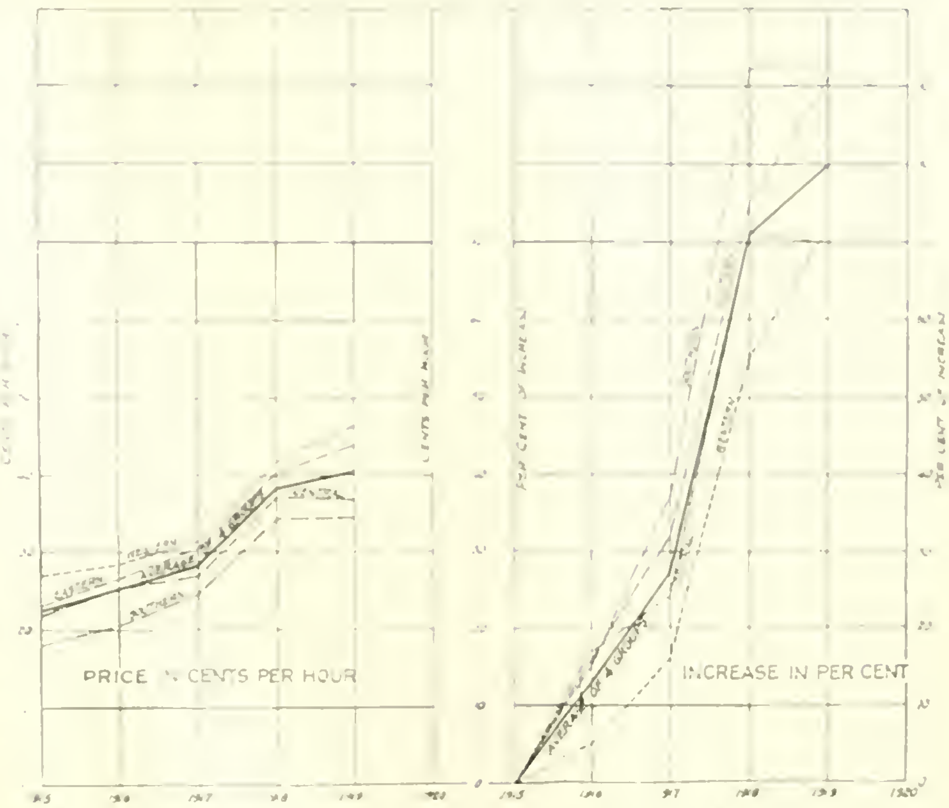


Fig. 1.—Increase in Cost of Unskilled Labor Over Pre-War (1915) Basis, Without Allowance for Loss in Efficiency or Output, Which Is Estimated at 25 Percent More or Less.

One-Eighth Revenue of Private Water Works Goes for Taxes.—Analysis of taxes paid by privately owned water works shows interesting results. Excluding the returns from water works located in the state of Pennsylvania, because the basis of taxation is quite different there and incomparable with that prevailing in other states, it appears with respect to the privately owned water works that, under average conditions

1. One-eighth of their gross income is paid out in taxes;
2. The tax payments are equivalent to nearly 30 per cent of the net income applicable to depreciation, interest, dividends and surplus;
3. The increase in taxes paid in the year 1919, over those paid in 1915, was 68 per cent or slightly over two-thirds;
4. The increase in the taxes paid in 1919 over those paid in 1915 constituted 27 per cent or slightly over one-fourth of the increase in the cost of operation (including taxes) of these works.

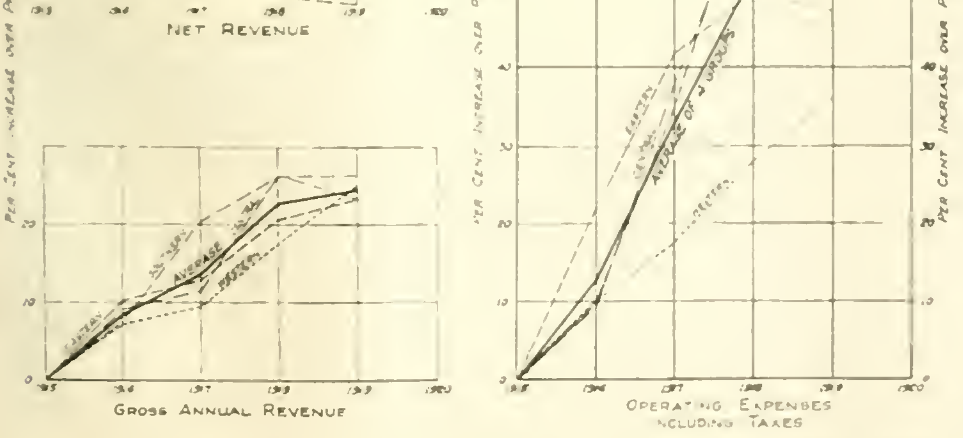


Fig. 2.—Gross Annual Revenue, Net Revenue and Operating Expenses, Including Taxes, as Shown by Records of About 50 Typical Waterworks.

Summit of High Prices Reached.—It is generally conceded that the summit of the high prices has been reached, where it has not been passed, and that, as to materials at least, and probably in lesser degree as to labor also, some recession in price is to be looked for. There is still, however, so marked a shortage of materials and labor, comparable with the demand, that construction costs are certain to remain high during the year 1920.

Financial Outlook for Water Works.—The financial outlook for existing water works is not encouraging. It is evident that the earnings during the war period have not been adequate to maintain the properties and pay a fair return upon their value. Such a condition cannot long continue without serious future embarrassment. The position that may be taken by the public service commission for their regulatory authorities, will be reflected later in the character of the service rendered. If fair advance in rates be granted, first class service can be maintained. If this advance be retarded or be not adequate, a declining service must result. The increase in rates in the face of [illegible] INCREASE IN COST [illegible]ALS TO WATER- [illegible] FROM PRE-WAR [illegible]STS UP TO 1920.

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Pct Incr Over (Pre-war Basis) [illegible]	1917	1918	1919
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27	113	[illegible]	184
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16	72	[illegible]	91
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16	24	71	70
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15	[illegible]	92	92
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16	55	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13	27	71	80
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	$69.20	27	113	179	184
[illegible]	[illegible]	2.64	[illegible]	[illegible]	[illegible]	13	71	71	85
[illegible]	[illegible]	$1.51	[illegible]	[illegible]	[illegible]	19	88	87	72
[illegible]	[illegible]	2.14	[illegible]	[illegible]	[illegible]	20	62	94	77
(1) Eastern	[illegible]	[illegible]	[illegible]	$6.00	$5.11	27	100	101	82
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.57	15	56	88	89
[illegible]	[illegible]	2.01	[illegible]	[illegible]	[illegible]	5	58	102	97
(1) Western	[illegible]	1.27	[illegible]	.92	1.70	16	59	99	183
[illegible]	[illegible]	1.21	1.77	.57	1.61	15	69	97	63
[illegible]	[illegible]	[illegible]	1.00	1.28	....	0	11	139	...
[illegible]	[illegible]	1.50	2.57	4.07	[illegible]	9	86	193	197
Aluminum [illegible] Group.									
(a) Eastern	1.12	1.72	1.48	1.45	1.66	51	33	29	48
(b) Central	1.21	0.91	1.25	1.50	1.40	0	37	65	54
(c) Southern	1.08	1.38	1.18	1.78	1.56	28	37	65	41
(d) Western	1.14	1.21	1.51	1.53	1.79	6	32	34	57
(e) Average	1.06	1.30	1.13	1.56	1.60	22	35	17	51
(f) [illegible] N. Y. [illegible]	2.28	4.63	1.57	....	....	..	....	..	..

*Range $56.60 to $83.50 per ton.
†Small market makes record of doubtful value.

TABLE II.—LABOR PRICES PAID BY WATERWORKS IN THE VICINITY OF BOSTON, MARCH 23, 1920.

	Cities.	Unskilled Labor Per Day, Nominal Rates.	Unskilled Labor Per Hour, Actual Rates.	Pipe Layers and Caulkers, Per Day	Pipe Layers and Caulkers Per Hour.	Hours Per Week.	Holidays.	Vacation 2 Weeks Paid.	Increase in wages Anticipated.
1	Boston	$4.00	$0.586	$4.25-5.00	$0.621-0.732	44	Paid.	Yes.	No.
2	Somerville	3.75	0.549	3.85	0.564	44	Paid.	Yes.	....
3	Newton	4.00	0.526	4.21-4.32	0.557-0.568	44	Not paid.	No.	?
4	Lexington	3.50	0.427	3.75	0.469	48	Not paid.	No.	Yes.
5	Waltham	4.16	0.589	4.48	0.635	44	Not paid.	Yes.	No.
6	Everett	4.25	0.621	4.75	0.621	44	Paid.	Yes.	Yes.
7	Chelsea	4.00	0.586	4.25	0.621	44	Paid.	Yes.	No.
8	Quincy	4.00	0.586	4.50	0.659	44	Paid.	Yes.	No.
9	Medford	4.25	0.621	5.00	0.732	44	Some.	Yes.	....
10	Melrose	4.00	0.586	4.25-4.50	0.681	44	Paid.	Yes.	Yes.
11	Revere.								
12	Watertown	4.00	0.586	4.25	0.621	44	Paid.	Yes.	Yes.
13	Arlington	4.00	0.586	4.25-4.50	0.621	44	Paid.	Yes.	Yes.
14	Milton	4.00	0.534	4.50	0.60	48	Paid.	Yes.	No.
15	Winthrop	4.00	0.534	4.25	0.567	48	Paid.	Yes.	No.
16	Cambridge	4.00	0.586	4.25	0.621	44	Paid.	Yes.	....
17	Brookline	4.25	0.584	4.42	0.608	44-48	Paid.	Yes.	No.
18	Marlboro	4.00	0.500	4.25	0.531	48	Not paid.	No.	Yes.
19	Hudson	4.00	0.518	4.50	0.582	48	Not paid.	Yes.	No.
20	Fitchburg	4.40	0.569	4.96	0.642	48	Not paid.	Yes.	....
21	Beverly	4.50	0.659	4.75	0.694	44	Paid.	Yes.	....
	March 23, 1920 Average	$4.05 50.6	56.7	$4.38 54.7	61.	13 of 44 & 8 of 48	14 Paid. 6 Not.	17 Yes. 3 No.	
	April, 1919 Comparative average	$3.16 43.2	46.1	$3.82 47.7	51.	15 of 44 7 of 48	13 Paid. 8 Not.	16 Yes. 5 No.	

the present high cost of living will be very distasteful to the public and in some cases induce active opposition. Therefore it is important that in making application for relief, the evidence should be clearly presented by the water works authorities, that the facts may speak for themselves and the difficulties of the commissions be minimized.

Work to Proceed on $2,500,000 Sewer at Kansas City.—The Supreme Court of Missouri on June 26, handed down a decision holding that Kansas City had full power to construct the Turkey Creek sewer and that the proceedings under which it was proposed to have the big project completed were legal in all respects. The sewer district drains 4,782 acres or about one-eighth of the property within the city limits. It is designed to take off the surplus water when Turkey Creek overflows. The contract for the sewer was let some months ago to the Thomas Kelly & Sons Contracting Co., who will at once begin construction. The contract amounts to about $2,500,000.

Cost Plus Contracts for Waterworks Construction*

By GEORGE W. FULLER,

Consulting Engineer, New York City.

Some water works construction must go forward. With conditions as they are at present the contractor, if he bids on a lump sum or unit price basis, is bound to name a price which in his opinion will protect him from loss and if possible assure a reasonable return on his capital investment and for the work of himself and his organization. Under these circumstances it is important to discuss briefly the cost plus form of contract with a view to seeing if the burden of uncertainty in some respects cannot be shifted from the contractor to the owner to the advantage of all concerned. In fact, if construction work is to go forward there are some projects where such steps seem imperative.

Legality of Cost Plus Contract. Before pointing out briefly the advantages and disadvantages of the cost plus form of contract, it is well to recall that there is serious doubt as to the legal right, of municipalities in some localities at least, to enter into such contracts. State and provincial laws and municipal charters usually call for the letting of contracts for public works by open competitive bidding for all work in excess of certain specified amounts. Also such laws provide, almost without exception, that contracts shall not be made in sums in excess of appropriations duly authorized and in some cases above the estimates of the engineer of the governing body.

As regards the first restriction the intent is obviously to take advantage of competition in making sure of proper market prices.

The second restriction is a check on total estimated costs by actual bids for the work. In the absence of preliminary bidding, work might be started when appropriations are insufficient for completion, or opportunities might be lost for reducing costs by subsequent lettings through correction of misunderstandings as to construction procedures.

Stabilization through such restrictions should not be abandoned unless there is a great emergency.

Cost Plus Contracts.—There have been and always will be certain construction problems in which some means of payment in the form of actual cost plus a percentage or lump sum is legitimate and desirable, if not necessary. This is true even with lump sum contracts in which certain features may be indefinite or subject to changes regarding the character of the work. Cost plus provisions for extra work, or supplementary contracts based on such arrangements or estimates, are also pertinent where sufficient investigation previous to a letting is undesirable or too expensive in time or money for the advantage gained [illegible] extensive street openings to locate existing structures and also in cases where the owner desires to retain [illegible] control of the work regardless of the cost.

---

*Abstract of a paper presented June 24 at the Montreal convention of the American Waterworks Association.

It is claimed that under the cost plus method a contractor has little incentive to keep down the cost of the work. This is frequently true of the cost plus percentage type but need not be true of the cost plus lump sum type. In any case it must be remembered that a contractor who will deliberately be inefficient on a cost plus project is equally sure to attempt improper or inadequate construction on lump sum or unit price agreements.

There have been a great many variations of the cost plus contract applied to construction work but the more important are:

Actual proved cost with labor and material furnished without restriction by the contractor plus a fixed percentage or lump sum to represent profit, supervision, financing, use of tools and plant, or any or all of these.

Actual proved cost of labor furnished by the contractor and with materials furnished by the owner, with a fixed percentage or lump sum as above.

Actual proved total cost for specified work plus a percentage for specified or unexpected extra or unforeseen work in connection with lump sum or unit price contracts.

Actual proved total cost to the contractor plus a sliding scale fee and upset maximum fee.

Actual proved total cost to the contractor plus a fixed plant charge and fixed construction fee.

Advantages Claimed for Cost Plus Contracts. The work may be started at any time and is not dependent on the prior completion of the plans.

The owner may radically increase or decrease the quantities during construction, with lump sum fees subject to review.

The owner may change the kind of construction during the progress of the work.

The contractor will not try to skimp the job as is often done after finding himself losing under lump sum or unit price contracts.

There is less need of having accurate preliminary estimates. In unit price contracts the preliminary estimate is often so approximate as to cause the contractor to gamble on some of the items, with resulting disappointment to the owner in the ultimate cost of the work. Such procedures sometimes cause an unfair result either to owner or contractor or both.

Unit price or lump sum bids require a set of specification definitions which are not always clear and are sometimes deficient and sometimes overlapping. Such ambiguities may lead to arguments and variations in cost which result in claims and suits for extra work.

Cost plus contracts may save the owner the money which the contractor usually adds to his lump sum or unit price bid to cover the complete but actually infrequent enforcement of material tests which cause him delay and expense, or necessitate the carrying of a large stock, entailing interest charges, storage space, rehandling, etc.

Cost plus contracts do away with the substantial sums usually added in lump sum or unit price contracts to cover the following uncertainties:

(a) Weather.
(b) Foundations.
(c) Changes and shortages in labor market.
(d) Changes and shortages in material market.
(e) Delayed deliveries of materials.

For cost plus work it is the contract and not the specifications which is the crux of the matter from both the owner's and contractor's viewpoint. The writing of the contract is more simple than the writing of the specifications.

Cost plus contracts tend to promote co-operation between the owner and the contractor.

Disadvantages Claimed for Cost Plus Contracts. There is no way of determining the approximate cost in advance and this upsets budgets where definite appropriations have been made or are required.

Competition—the key to efficiency—is killed.

Greater opportunity is offered for favoritism on the part of the owner's representative.

Where the same contractor has several jobs, the lump sum and unit price contracts will get the good workmen and the cost plus contract will get the drones and misfits.

A large general contractor [illegible] cost plus basis and [illegible] contractors on a lump sum or unit price basis. [illegible] the subcontractors [illegible] complete the work of the latter [illegible] the general contractor often treats them unfairly while he himself [illegible] a substantial profit for doing little or nothing.

Should work be started before plans are completed, many errors may have to be straightened out in cases where competent engineers would avoid them if given an opportunity to get out a complete set of plans and accurate estimates of quantities.

Engineers are tempted to be less thorough in their work when they know that there will be no comeback at them on account of extras resulting from their failure to have plans and specifications complete when needed. With cost plus contracts it may simply be a matter of correcting an error or supplying a deficiency when discovered, but the cost is there just the same although it may not appear as an "extra."

Engineers or other representatives of the owner must do an immense amount of accounting and clerical work in checking payrolls, material bills, etc., and expend much time and energy in expediting the delivery of materials.

A premium may be put on extravagances and waste by giving unscrupulous contractors and engineers a chance to take advantage of the owner.

The contractor may procrastinate in securing if not refuse to secure promptly adequate tools and equipment as to type and number.

A combination of the above disadvantages, although no one by itself may be sufficiently pronounced to permit the owner successfully to obtain relief, may cause grief for the owner, unless protected by a maximum fee to the contractor and by the assured adequacy of the latter's organization and equipment.

Pre-War Status of Cost Plus Percentage Contracts. Much large construction work was and is done by railroads and other corporations in this way but this is done usually because these corporations, unlike municipalities, are legally able to select competent contractors with efficient organizations and equipment to work under the immediate direction of a skilled and alert staff of the owner who for the most part purchases supplies and material direct. The Grand Central Terminal in New York is a case in point. Much of the work was first awarded to a contractor on a unit price contract but it was completed under a cost plus agreement.

There can be no question that some work can be as economically and efficiently done under the cost plus basis as in other ways. But in the water works field such work appears to form the exception rather than the rule under peace-time conditions.

Army Contracts for Construction Work. One of the best examples of cost plus percentage agreements is found in the U. S. Army construction work during 1917-18. Here the contract was on what is known as the "cost-plus-a-sliding-scale-fee" with a maximum upset fee.

Overhead expenses and interest costs reduced the actual profit to most cantonment contractors to less than 1½ per cent. In this case the specified cost of the work included all payments of whatever nature with the exception of overhead costs of the contractor including financing expenses.

The union scale of wages prevailing in the locality of the work under consideration as of June, 1917, was agreed upon by the Secretary of War and the president of the American Federation of Labor as the scale for the camp. Rules in reference to overtime, and for the regulation of hours of work, were agreed upon in advance between the constructing quartermaster and the contractor, in accordance with conditions prevailing in the district where the work was done.

The question of whether or not the Government got a fair return on its investment depended largely on the adequacy of the auditing and checking system which the constructing quartermaster carried out on the job.

There is no room for doubt as to the wisdom of the U. S. military establishment having acted wisely in adopting the cost plus form of contract for its emergency work. Speed was of vital importance. Abnormally high speed always means abnormally high cost. But in this war emergency abnormal construction costs were of no significance as compared with the saving in blood and general war cost which resulted from such construction speed.

In this connection it is well to recall that the government through priority arrangements had the benefits arising from [illegible] not only of materials and of labor but also of transportation. Such benefits do not attach to peacetime work in any field.

General Considerations Regarding Contract Work.—On contract work engineers should not be compelled to do the work of both the engineer and the contractor because contractors should be more capable than owners or their representatives to handle advantageously and economically the details of construction requirements. Contracts should therefore be drawn in such a manner as not to limit the work and responsibility of the contractor to the furnishing of labor and to the execution of details under the absolute direction of the owner and his engineer. Responsibility for good construction and final excellence of the work should rest with the contractor.

To insure satisfactory results from cost plus lump sum agreements the contracts should provide for the reimbursement of the contractor for all amounts actually spent by him, such expenditures being limited in the case of materials to their normal market value and for labor to price schedules of local labor unions. The lump sum fee allowance should include the services of the works superintendent and hand tools and such small equipment as would obviously be required for the work. For plant equipment, such as machine tools, excavators, cable ways, etc., a per diem rental under stipulated conditions should be fixed or bids should be received. To prevent disputes the plans and specifications should be as carefully prepared as for other types of contract.

Good examples of cost plus lump sum agreements are found in the U. S. Housing Bureau and other government contracts which provide for a rental price for plant equipment and a contractor's fee for services, on all of which bids were taken from a list of acceptable contractors.

The plant equipment fee covered the rental of all machinery, scrapers, scaffolding and tools, and all material which did not enter into permanent work. It did not include, however, lumber for temporary forms, concrete centering or the bracing and supporting of these forms or light staging or scaffolding on the exterior of structures.

The contractor from his fee was obliged to pay all costs of transporting, loading and unloading the plant equipment, and all upkeep and maintenance charges, fuel, oil, office overhead and general superintendency. A bonus was allowed the contractor, in addition to the lump sum fee which he bid, in the amount of one-fourth of any saving he was able to make as compared with his accepted estimated cost of the total work.

Under the agreement the contractor financed the entire construction work and was reimbursed by the owner for all such cost. A very strict system of inspection and accounting was maintained by the government.

Profit sharing methods have considerable merit over the straight cost plus forms in that they give the contractor some incentive to keep the cost of the work down. A method which has been used with considerable success in Canada is described by Mr. R. O. L. French. By its terms the contractor receives 2[illegible] per cent of the estimated cost and rebates to the owner 1[illegible] per cent of the actual cost.

Contracts Adjusted to Varying Labor Prices.—Mr. Morris R. Sherrerd, Chief Engineer of the North Jersey District Water Supply Commission, in a recent contract for the construction of the Wanaque Dam provided for an adjustment of certain labor costs after the year 1920, provided such costs were 1[illegible] per cent above or below normal 1920 prices. This leaves the burden of charges in materials costs on the contractor but causes the owners to share with the contractor abnormal changes in labor costs. The advantage of this type of contract as to labor over cost plus agreements lies in the fact that the contractor is compelled to exercise the same careful supervision and that there is the same necessity for economical construction methods as is required on lump sum and unit price agreements, but he is not obliged to shoulder all responsibility for unexpected price changes.

In the Wanaque Dam contract, labor is a controlling item, but on ordinary construction work, particularly on comparatively small jobs, and where the values of labor and material are more nearly equal, there would be less advantage in it. To be more generally applicable the adjustment in prices should if possible include material as well as labor, and furthermore the length of time between successive adjustments should also be made to conform to the size of the contract and to the probable duration of construction.

The adjustment of prices is more difficult in the case of materials than for labor because of the greater number of materials and also because of the variety of materials which might satisfy any particular specification. On this account the furnishing of the principal materials to the general contractor through separate contracts made by the owner may be advantageous in that the risk would be more widely distributed and the adjustment of prices made somewhat more simple and definite.

At a time when transportation facilities are abnormally inadequate the assumption by the owner of the responsibility of furnishing materials cannot eliminate wholly the troubles arising from the enforced intermittent use of the contractor's laborers.

Summary and Conclusion.—Pre-war construction contracts were for the most part, and rightly so, agreements on a lump sum or a unit price basis. Cost plus contracts were used only on certain large work done for private corporations or as a part of other types of agreements.

During the war the United States Government construction and such other work was done on a cost plus basis. Where proposals on a lump sum or unit price basis were obtained, the prices were intended to be sufficiently high to insure against loss due to constantly changing prices and the scarcity of labor and material.

Since the war, the procedure has been somewhat unsettled, with an effort to do away with some of the disadvantages of cost plus form and to combine so far as possible the good qualities of both types of contracts.

The unit price contract under normal stable market and transportation conditions is the most satisfactory. The lump sum contract is principally advantageous in that the final cost is definitely known at the outset.

Cost plus contracts, with proper provision for accounting and supervision, may be satisfactory where conditions are not definitely known and in the case of private corporations where well qualified contractors may be selected to work under adequate supervision. Under war conditions cost plus contracts were necessary and even now have many advantages.

Construction work for private corporations may be successfully carried out with proper safeguards under any of the discussed forms of contract. For general construction work under municipal control the nearer a contract approaches the well-established lump sum or unit price contracts, if indeed any departure from such contracts is legal, the more satisfactory will be the results secured.

Until such time, however, as the material and labor markets are better stabilized, contracts should in fairness place the burden of uncertainty on the owner and not on the contractor. This may be done as follows:

(a) For much municipal work a form of contract may be adopted along the lines proposed by Mr. Sherrerd, and modified as suggested as to labor and material adjustments at proper intervals.

(b) For municipal or other work contracts may provide for the furnishing by the contractor of such labor and materials as are reasonably stable, with adjustment for changes in the labor market, and with materials of unstable price furnished by the owner through separate contracts.

Construction work not absolutely necessary should be deferred, and materials and labor should be diverted so far as possible to work which is absolutely necessary.

So far as possible necessary improvements should be made by repairing or enlarging present works, and new works should be confined for the present to immediate needs.

Court Decision of Interest to Illinois Drainage Engineers.—A decision of interest to drainage engineers has been rendered recently by the Supreme Court of Illinois. The lower court of McHenry County abandoned the Cane Creek Drainage District, holding that engineer's fees, attorney's fees, and even the commissioners' fees, were not a part of the court costs, which had to be paid within 30 days in order to abandon the work. The Supreme Court has now reversed the lower court, and remanded the case, declaring that the order of the lower court was destructive of a remedy provided by the law, and prohibited by constitutional provision, as it deprived these men of their rights under their contract with the commissioners, as engineer, and attorney. This decision, which has been awaited with interest by the engineers and attorneys over the state, will, it is expected, give more stability to drainage districts, which were endangered by this new amendment. A. L. Webster of Wheaton, Ill., was the engineer for the district.

Amalgamation of Waterworks Associations to Secure United Action*

By CARLETON E. DAVIS

Chief Bureau of Water, Philadelphia

The widest opportunity for this association, I feel, lies in a change in the relationship between the sections and the central organization. The sections must be developed, those already in existence must be strengthened, new sections must be created, all with a view of a final amalgamation in one central organization of the entire waterworks interests of the country. This process, carried to a logical end, will not destroy our existing organization but perhaps change its character, opening up to it a much wider field of usefulness along somewhat different lines. To meet the situations that are before us today and that will arise in the years to come, to prevent lost motion and eliminate unnecessary duplication, all the waterworks of the country should function for their common interests through a central body which will be representative of all localities and which should be organized to meet all conditions and needs.

The American Waterworks Association, when it adopted its name, expressed the intention to serve as this central body. The question before us today is whether we propose to grasp the opportunity to act or whether we shall let the opportunity pass us by. Acceptance of the present as we find it and committing the future to our successors is the easiest course. I believe our association will elect to follow the more difficult but more fruitful path.

The majority of our members are restrained in their activities by regulations imposed upon them by public service bodies, or by the restrictions of legislative enactments, or by the limitations of city laws and ordinances. Many of these restraints are irksome, and are not accepted calmly or without chafing under the restraint. Along the field of organization work we have a relatively free hand to organize and develop. We have an opportunity to demonstrate that the waterworks engineer and operator is a capable organizer, and, when given the opportunity, can conduct his own affairs with efficiency, and at the same time with due regard for the interests and welfare of the public, with an eye to the future and an alertness for the present. Necessary protests against undue outside restraint will come with much greater force if supported by the weight of a compact, comprehensive, well-organized and conducted association.

It is stated on good authority that the investment in waterworks represents the largest total in the entire field of comparable utilities. Waterworks officials know that their plants, of all utilities, supply one universally indispensable commodity vital for human existence and basic for all community life. We have common interests, and that we are grasping for methods of expressing this interest by working together for a common end is shown by the number of waterworks organizations. The next step forward is the affiliation of the several organizations to handle matters of mutual interest with the power and weight that come from large numbers, unity of purpose and harmony of ideas.

Organization is the dominant note heard throughout engineering and allied fields at the present time. The American Waterworks Association, through accredited representatives, recently attended a National Council in Washington of organizations concerned with public utilities like our own, seeking to co-operate, offensively and defensively, in matters vitally affecting the interests, personal and official, of their members. Whatever may be the final outcome of such efforts, or whatever may be the path the council of affiliated societies may elect to follow, self-respect demands that the waterworks of the country shall be able to speak as a unit at such councils and with the weight attaching to full and not partial numbers.

Waterworks problems are physical and material, social and political. The first two mentioned are common, irrespective of locality. The last two mentioned depend upon the human element, and human nature has common characteristics the world over. Waterworks men on this continent have underlying interests and will continue to co-operate in the future as they have in the past.

We do not realize our strength because we have never attempted to exert it as a unit. Unorganized society is helpless against attacks and demands of relatively small but effective because organized groups working together. The existing lack of cohesion among waterworks men places them relatively in the position of the present unorganized public, powerful but helpless because of its inability to work together. Sometimes among our own ranks we hear reference to the so-called little fellow and the big fellow. Each one of our members has something to give and something to receive. The perpetuation of the false idea of big and little, great and small is harmful because it is based on wrong premises, is unreal and exists only in the imagination.

The public water supplies of the country are developing from year to year, meeting the growth of the country. They present highly complex technical and engineering problems. The period of outside regulation has been with us for some time past and is increasing. Local, state and national health organizations are charged with functions relating to water supplies which are sometimes arbitrary and absolute. Public service commissions are given or assume increasing authority from year to year.

Waterworks operators must determine for themselves whether they propose to accept, without a voice in the matter, standards which may be imposed upon them from the outside, or whether they propose to set up certain standards for themselves which outside bodies must of necessity accept because of the authority behind the conclusions of the waterworks operators. If the latter is to be the case, the waterworks men must take the initiative; otherwise it will be taken from them. If the waterworks men do not lead, they must follow.

Standards of practice and procedure must be done through committees and committee work will become of increasing importance. The path of the committees must be smoothed as much as possible. When the authority for committee work can emanate from a central body, representative of all the waterworks of the country, when co-operation comes logically and as a matter of course and not under option of possible rival organizations as at present, the desired end will be in sight.

---

*Abstract of Presidential address at Montreal Convention of American Waterworks Association.

Filter Plant Operation at Grand Rapids, Mich.

Records of filter plant operation at the city of Grand Rapids, Mich., for the year ending March 31, 1920, are available in the recent annual report of Walter A. Sperry, chief chemist of the plant.

During the year the gross pumpage to the filtration plant was 5,131.3 million gallons, or an average of 14.06 million gallons per day. This was an increase of 12.7 per cent over the preceding year. Deducting wash water, amounting to 0.8 per cent, the net amount filtered was 13.94 million gallons per day.

The cost of operation per million gallons was as follows: Wages, $4.25; chemicals, $7.23; power, $3.85; supplies, $1.33; or a total of $16.66, a decrease of $0.22 per million gallons over 1918. This decrease, however, was due largely to the inability to obtain the required amount of lime during the winter months.

The average price paid for chemicals per ton was: Lime, $12.01; alum, $32.00. The average amount of chemicals added per gallon of water were: Alum, 0.8 grains; lime, 5.6 grains. The average total hardness of the raw water was 241 parts per million and of the filtered water 135 parts per million. The average color in the raw water was 31 parts per million and in the filtered water 13 parts per million.

The plant has been operated for the entire year on the intermittent plan of reduced lime feeds. The standard of hardness maintained has been that of Lake Michigan, 7.5 to 8 grains per gallon. This standard seems to have been reasonably acceptable to the users and there continues to appear to be no doubt but that this plan is acting effectively to reduce the "after deposits." Never before has the small amount of scale been found in the water cylinders of the high service pumps as at present. This year it was possible to omit the usual overhauling of the sand beds, as the filters were free from the usual mud balls or other deposits. There have been no complaints of bad effects on furnace coils.

Effect of Flood on Flexible Concrete Block Revetment of Miami Conservancy District

A considerable part of the work of the Miami River improvement, which forms a part of the flood prevention project of the Miami Conservancy District, has been the protection of the banks and levees, at especially vulnerable points, against the scouring action of strong currents during floods, by the use of concrete revetments as an armor covering the earth materials of which the banks and levees are made. This revetment consists of two main parts, a strip of concrete slabs occupying the lower part of the levee slope and a strip of smaller concrete blocks laid along the edge of the river channel adjoining the slabs and anchored to them. These blocks are 24 in. by 12 in. by 5 in. in size. The method of constructing them was described in the August 27, 1919, issue of Engineering and Contracting. They are laid [illegible] breaking joints. Steel cables are strung horizontally through holes in the blocks, weaving them into a continuous fabric which is quite flexible. The cable is run at right angles to the river bank and is anchored in the concrete of the slab on the levee slope and to heavier longer blocks which stiffen and strengthen the outer edge of the fabric.

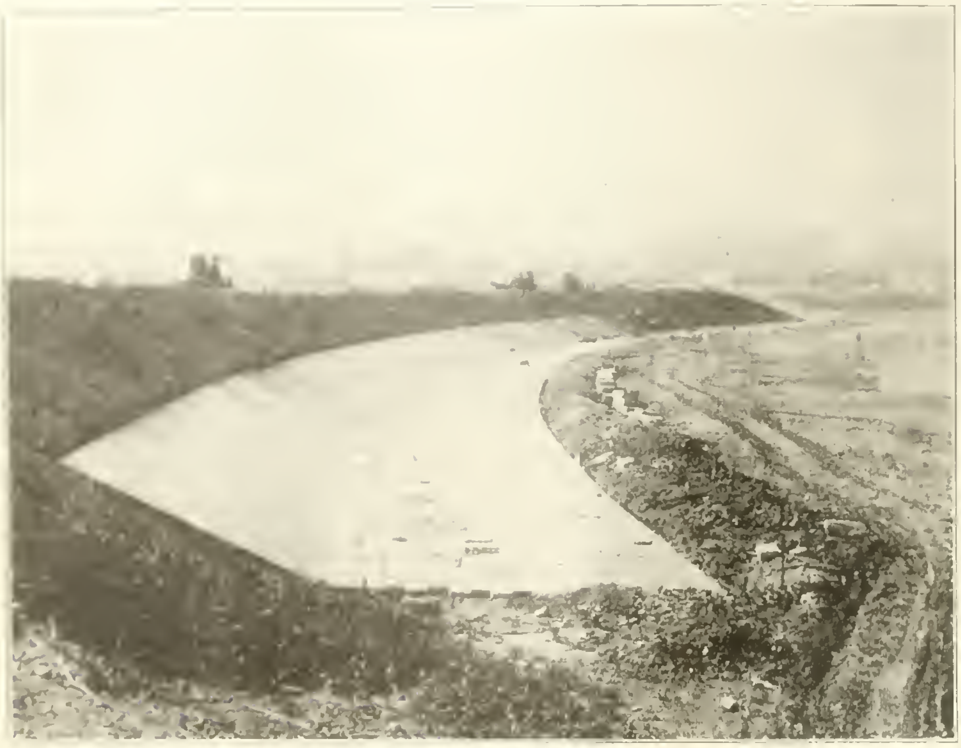


Fig. 1—Finished Section of Concrete Revetment. Picture Was Taken in May, 1920.

At the foot of the levee slope a row of wooden piles is driven, their tops capped by a low concrete wall built integral with the levee slabs, and to which the flexible fabric is anchored by the cables through every block. Cross walls of interlocking steel sheet piling are placed every [illegible] ft. in the length of the revetment, running crosswise, from the base of the concrete slab slope half way to the river edge of the flexible block structure and are anchored both to the slabs and to the blocks. This affords additional security against any possible undercutting of the levee. The flood of last April subjected this revetment to a particularly severe test. During this the water reached the 16 ft. stage—the highest since the disaster of 1913. The action of the flood in this revetment is indicated in an accompanying illustration, which with the descriptive matter are taken from the June Miami Conservancy Bulletin.

The action indicated in Figs. 2 and 3 took place at a particularly vulnerable place, just below the Island Park Dam, in Dayton, O. At its east end, this dam abuts upon the levee some distance up the slab slope. The dam crest being level, the result is that all stages of the river water at the east end of the dam is pouring in a sheet, thicker or thinner, upon the levee slabs, thence down their slope and across the flexible floor, which also has a slight slope, till it reaches the unprotected river bed, at the lower edge of the mattress. In its rush down the levee slope, it acquires high speed, and strikes the unprotected river gravel like a liquid excavator, or modified "hydraulic monitor," excavating a channel for itself along the edge of the revetment for a considerable distance downstream. The gravel beneath the revetment edge sloughs off into this channel, permitting the lower portion of the flexible floor to sink gradually beneath the water surface, and cover the excavated slope. It is notable that this action, once it has sufficiently deepened the channel next the revetment edge, is self-curing, the water of the deepened channel forming a liquid cushion which stops further destructive erosion of the gravel bottom. The deepest erosion is in fact due to the downstream rush of the water a little further below for which the action just referred to seems to give an opening wedge. The same cushioning action, however, takes place here also, and the eroded layer rapidly thins out downstream.

The extent of the erosion which can occur at the edge of the revetment and still be mended will vary somewhat with the nature of the material eroded. In the gravel which constitutes the bed of the Miami River, the shore slope assumed by the excavation is steep, that the location shown in

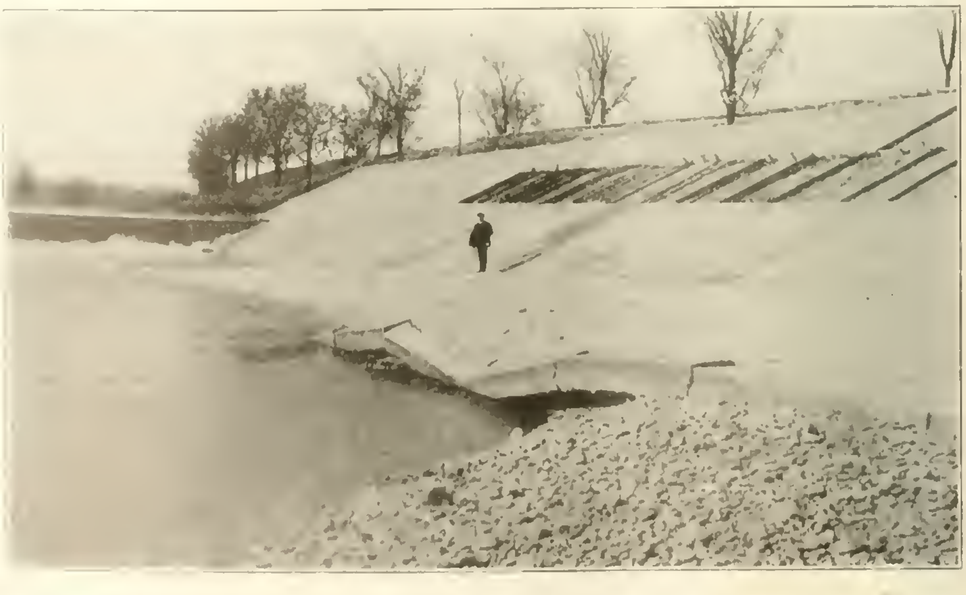


Fig. 2—Flexible Revetment in Action. The Flexible Mattress Sank a Maximum of 7 ft. Below Its Original Position, Its Steel Cables Keeping the Structure Intact. The "Hump" in the Foreground Is Caused by Heavy Boulders, Which Protected the Ground at This Point from Erosion. This Picture Was Taken Before the Flood of April 20. Fig. 3 Shows What the Flood Did to This Revetment.

Fig. 2 measurement showed the river edge of the revetment had dropped about 7 ft. Following this time came the flood of April 20, and it is gratifying to note that under these severe conditions the additional erosion was only about a foot. The width of revetment provided is sufficient to permit a considerable drop further without danger, the erosion ceasing before the full adaptability of the revetment is exhausted. The stability of the Miami River gravel together with the ample factor of safety provided for in the design gives strong assurance of the protection of the levees under maximum flood.

It is believed that at the point where the test occurred the conditions are more severe than anywhere else along the length of the revetment.

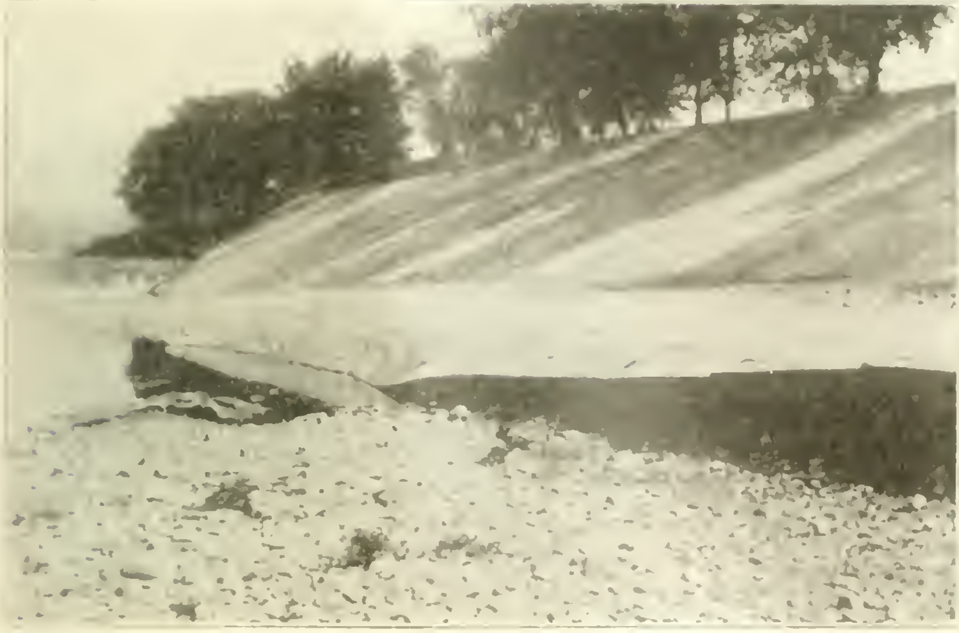


Fig. 3—Flexible Revetment After Flood of April 20. The "Hump" Shown in Fig. 2 Persists, but Is Considerably Reduced. Note the Slight Additional Erosion Due to the Flood. At the Right the Revetment Edge Still Remains in Its Original Position, Although the Gravel Next to It Has Been Somewhat Cut Down. The Flood Reached a Stage of 16.1 ft., the Highest Since 1913. Under the Circumstances, and Considering the Peculiar Vulnerability of the Levee Slope at This oPint, the Behavior of the Flexible Mattress Is Gratifying to the Engineers.

Mayors' Salaries Fixed by Legislative Act.—The lower house of the State legislature of Louisiana on July 6 passed a bill fixing the annual minimum salaries of the mayor and councilmen in every city in the state, with the exception of New Orleans. In cities of the first class between 40,000 and 60,000 population, the salary of the mayor shall not exceed $6,000 and the councilmen $5,000. More than 60,000 in population, the salary of the mayor shall not exceed $7,500 and the councilmen $6,000. In cities of the second class, between 2,500 and 5,000 population, the salary of the mayor shall not exceed $1,700 and the councilmen $500. Between 5,000 and 10,000 population the salary of the mayor shall not exceed $2,500 and the councilmen $1,500.

Between 10,000 and 14,000 the salary of the mayor shall not exceed $3,000 and the councilmen $2,500. Between 14,000 and 25,000 population, the salary of the mayor shall not exceed $3,500 and the councilmen $3,000. Between 25,000 and 40,000 population, the salary of the mayor shall not exceed $4,500 and the councilmen $3,500. The population of the various municipalities shall be determined by the recent United States census, it is provided. In the event that any city of the second class with a population of more than 10,000 but less than 14,000 and operates its own street railway and waterworks system, the salary of the mayor shall not exceed $4,000 and the councilmen $3,500. Where such city has a population in excess of 14,000 but less than 20,000, the mayor's salary shall not exceed $4,500; between 20,000 and 30,000 population, the mayor's salary shall not exceed $5,000 and the councilmen $1,500; between 30,000 and 40,000 population, the mayor's salary shall not exceed $6,000 and the councilmen $5,000.

Suggestions on Mechanical Filtration Plant Operation

Useful suggestions on the operation of a mechanical filtration plant of the gravity type are given in a recent issue of "Shops and Field News," a publication of the Pittsburgh Filter & Engineering Co., from which the matter following is taken.

In placing the plant in operation be sure that all valves controlling the flow are properly closed. In starting to fill the sedimentation basin be sure that the chemical solution feed is started first. Make it a rule always to open the coagulant supply pipe before starting the pumps that pump water to a coagulant basin. A small amount of excess solution will do no harm, while to fail to do this may result in a considerable amount of water getting into the coagulating basin before coagulation is started. It is absolutely essential to secure coagulation before getting results.

Securing Proper Coagulation.—Regulation of the coagulant solution must be made in accordance with the conditions of the raw water supply and should vary probably from 1 grain or even less per gallon to possibly as high as 5 or 6 grains when the water is exceedingly turbid. Judgment combined with the experience is the only way to determine the exact amount necessary to produce results.

The coagulation should appear in the form of a floc in the water, the floc taking the form of a distinct flake. This can be seen readily in the open basin with the sun shining upon the water, or have a clear glass available so that samples can be dipped from the basin and, when held up to the light, the distinct floc can be seen if the proper coagulation has been secured.

The greatest amount of the suspended matter should be precipitated in the settling basin so that the water when applied to the filter bed is comparatively clear. This must be taken in a comparative sense only, for when the water is very turbid it, of course, will be somewhat muddy as it goes to the filter bed, but will be much clearer than the raw water.

At periods when the raw water is exceedingly clear it may be necessary to use a little larger amount of alum to secure a coagulation than when it has a certain amount of cloudiness or turbidity, for in the former case the blanket on the filter is formed entirely by the flocculent matter. In all cases, however, be sure that you have a distinct floc as the water goes to the filter bed.

There probably will be some condition, when it would be advisable to apply the coagulant at the baffle wall in the basin or various points in mixing chamber, rather than at the inlet chamber, on account of the small amount of turbidity the water contains. When it is extremely muddy, however, application should be made always at the inlet chamber.

If you do not secure proper coagulation there is some definite reason, either a sufficient amount of coagulant has not been applied or it may be possible that, in the event of continued rains and extremely heavy turbidity, the water does not have sufficient alkalinity to properly take care of the amount of aluminum applied.

In event of a difficulty of securing coagulation, immediately have tests for alkalinity made. Each grain of aluminum applied per gallon requires about 0.8 grain of alkalinity for its proper use, and there should at all times be a surplus of alkalinity of possibly a grain and a half over that required for the coagulant. In the possible event of a deficiency in alkalinity, temporary application of a solution of [illegible] sufficient to make it up, may be applied. [illegible] you of the amount necessary [illegible] alkalinity test.

When it is probable that this will occur in the water, it is advisable to be sure to have on hand an ample supply of [illegible] anticipating your needs of this material so that there is no possibility of your having to operate without proper coagulant, as without it results cannot be obtained.

Starting the Filtering.—After having filled the coagulating basin with the raw water properly mixed with the coagulating [illegible] as it passes through the mixing chamber, open the valve [illegible] the influent to the filter bed, allowing the water to flow into the bed through the troughs on to the sand bed.

This should be done slowly so as not to get the bed air bound by flooding the surface and trapping the air in the sand. After slowly filling the filter box and allowing the water to rise to the level of the coagulating basin, open the filter waste valve for a few moments, and let the first filtered water pass to the sewer, then open the filtered water or effluent valve and close the filter waste valve to the sewer and the filter plant is in operation.

The filters should be kept in operation until the loss-of-head gages show a loss of head of approximately 10 ft., at which time it will be found that the amount of water passing through the filters will be considerably less than the normal rated capacity, which should be about 2 gal. per square foot of area. When the capacities decrease below this quantity, then it is an indication that the beds are in such condition due to accumulation or deposits on the surface of the sand bed, and that they require washing. It will be found, on the average, that this will take place when the loss of head gage shows a loss of head of 10, and in some cases as high as 12 ft., at which time the filter should be [illegible] and properly washed.

How to Wash the Filters.—In doing this, close the influent valve and allow the water to filter down until within 2 or 3 in. of the top of the sand bed. Then close the effluent valve and open up the sewer valve. Next open up the wash valve, letting the wash water under pressure into the under-drain system. The pressure applied to the under-drain system for washing should be approximately 10 to 12 lb. per square inch, equivalent to a head of 25 or 30 ft., which is ample for proper washing. Too great a pressure will disturb the gravel and result in the sand drifting down to the gravel bed and into the under drain system, gradually clogging it up.

The wash water valve should be opened slowly, so as to get the pressure thoroughly distributed over the sand bed and permit the sand bed to rise evenly over its entire surface for several inches; then, as the pressure increases due to the opening of the valve, the sand will separate and break up and as the valve is opened to its full capacity the velocity of the wash water increases, carrying with it the accumulated suspended matter and separating the sand grains and scouring them thoroughly, carrying the accumulated matter away with the wash water into the wash troughs and thence to the sewer.

The process of washing under ordinary conditions will require from 6 to 12 minutes, depending upon the condition of the bed. In closing off the wash water, it should be done gradually so that the sand will settle in regular grades according to the size and the surface will be smooth and level at the end of the wash. No definite time can be given for washing as it will depend upon the appearance of the wash water as to when sufficient wash will have been applied.

In this connection it is well to note that when a filter plant is first put in operation, the sand should be washed more frequently and the washing should be of longer duration than later on when the plant is in normal operation and the sand bed is in perfect condition. It is necessary to scrape the very fine sand off the surface two, and sometimes, three times in order to get the right grade of sand left and get rid of the very fine sand. This is usually done by the erector, but it may be necessary to scrape it again later on. This very fine sand will wash up to the top of the bed and will appear almost as a mud layer but is easily distinguished after the washing operation has been completed. If allowed to remain in the beds it results in extremely short runs, but of course is of no particular disadvantage otherwise, as the [illegible] the sand grains are so extremely fine that they quickly fill up with deposit.

After completing the washing operation, the wash water pressure is closed off and the sewer valve is next closed. The influent valve supplying the treated water is opened and the filter allowed to fill up, then the rewash connecting to the sewer is opened for a few moments and the first water allowed to waste; this should take place in from 10 to 15 minutes; it is then closed and the effluent valve to the clear well is opened and the filter is in regular operation.

Actual Results Depend on Observation and Experience of Operator. This in a general way covers the operation for mechanical parts of the operation of a filter plant. Actual results must naturally depend on observation and experience of the operator, as difference in conditions of water will necessitate different methods of treatment and handling. This means sedimentation, process of washing and the handling of the filters generally. The operator should take particular care to note the condition of the sand bed at all times and from the first evidence of any formation of any hard spots in the bed, use extremely long washing and thoroughly break up these spots with a garden rake or some other means; for if not taken care of immediately they will gradually grow larger and in time put a considerable portion of the bed out of commission, while if taken care of immediately they can readily be broken up and avoided. They are due primarily to improper washing conditions, and this is one of the most vital points to watch in the operation of a filter plant if continued good results are desired.

The operator should take particular care to keep controllers properly adjusted and in proper operating conditions at all times, also all gages and operating parts, in order that he may have a correct indication of what is going on in the operation of the plant. In the event of any part becoming broken, do not delay but have it repaired immediately so that it is always in shape to perform its intended function. Do not pass more water through the filter than it is designed or intended to purify except in the case of an extreme emergency.

Carefully observe the results of different treatments of the water at different stages and under different conditions so that you can form an idea of what treatment will give the most satisfactory result for each condition.

Underground Water Waste Control in New York City

The leaks that are the most difficult to locate are those which come from abandoned service pipes which have been bent over and hammered up, and at some later date open and start to flow. Some of the methods used to locate such leaks and the results accomplished are contained in two papers read before the New York Section of the American Water Works' Association at its last meeting. One of them is by H. T. Havill, Assistant Engineer, Department of Water Supply, Gas and Electricity, New York City, and the other one is by F. B. Nelson, also Assistant Engineer in the same department. The following notes are from these papers.

Some idea of the damage caused by waste of water from such abandoned services may be obtained from one leak which was located and stopped. While aquaphoning in the vicinity of 65th St. and 5th Ave., a leak noise was heard on the line gate in 65th St. A bar was driven through the pavement to the pipe in successive places and the aquaphone used on it until the most distinct vibration was noted. An excavation was made there and an abandoned tap was located which, when shut off, stopped the flow of water to houses on East 65th St. This has been running since the house was built, some ten years, and was supposed to have been a spring. The flow of water into the premises was about 100,000 gal. per day. To take care of this supposed spring, the entire cellar had been waterproofed at a cost of $12,000. This failed to keep the water out, and an electrically operated centrifugal pump and a water siphon were installed. After the leak had been stopped, the monthly meter bills for water were reduced from $41.10 to $8.10, showing that the siphon consumed $33 worth of water per month. This together with the electrical bill to run the turbine amounted to $500 per annum. In ten years it cost the householder more than $17,000 and wasted 365,000,000 gal. of water.

Another very typical condition of waste caused by an abandoned service, was exemplified in the leak located some time ago running into the Russell Sage Foundation building. The basement of the building had been waterproofed to take care of the ground water, but when an old abandoned service opened up and started to flow, causing a pressure under the floor, the tar which had been used in waterproofing started to work up through the concrete and formed globules which eventually burst. The abandoned service which caused this trouble was located by driving a bar through the pavement and into the ground, until the point of the bar penetrated the sub-surface water level. Marking the bar at the street surface and withdrawing it, and measuring from the mark to the point where the water wet the bar, a point was determined on the gradient of the sub-surface water, which if followed up will lead to the source of flow as the gradient will rise to a maximum at the source. This leak cost the owner of the building about $3,000 to care for before the trouble was located.

Another case was that of a ¾ in. tap which was found leaking in Columbus Ave. to 76th St. There was no street indications of a dangerous condition and the leak was located by the aquaphone and sounding method. When the first sounding was made and the bar had penetrated the concrete foundation of the street the next blow with a hammer drove the bar through the pavement and out of sight. An excavation was made and it was found that the water had washed out sufficient earth to leave a hole large enough to put a good sized truck in and had undermined a 30-in. gas main which together with the foundation of the street surface was the only support given to street traffic over this section.

It is very probable that if this condition had continued to exist very long, heavy trucking would have fallen into the hole as well as breaking the 30-in. gas main.

In New York City, speaking in round numbers, about one quarter of the 390,000 services are metered; also about one quarter of the total supply passes through meters. Thus about three-quarters of the 600 million gallons per day delivered to the city is unguarded as to waste except for the special and limited effort which the Department of Water Supply is able to make towards even a partial control.

The possibilities for the development of underground leakage depend largely on sub-surface conditions. In the Boroughs of Brooklyn, Queens and Richmond, as a rule, the existence of under-ground leakage is revealed by visible surface indications. In Manhattan and The Bronx the reverse is true, and excluding sudden or serious breaks, the chances of a leak showing at the surface are very remote. The difficulty of locating leaks in these two boroughs is often materially increased, particularly in lower Manhattan, by the congestion of sub-surface structures.

Since 1912 a special force under engineering supervision has been assigned principally to the work of underground waste detection in these boroughs. To date this force has located and repaired underground leakage totaling over 75 million gallons per day. Several leaks of approximately 500,000 gal. a day have been found flowing to the sewer through a clear channel directly under rock filled macadam streets, with no visible surface indications. Numerous other cases have been found in which the evidence is quite conclusive that the leak had existed for years.

Since 1917 it has been found profitable to utilize this special force in relieving the repair shops of cases of leaks location in which extensive street openings, traffic interference or damages could be avoided by the application of engineering methods, and the force has been increasingly utilized in this way until their waste detection work has come to be almost exclusively on complaint and emergency matters, and the systematic search for leaks has had to be abandoned. This, together with the increase in salaries and wages has advanced the cost of the work per 1,000,000 gal. saved from $1.15 in 1917 to $3.19 in 1919.

The force for the past three or four years has consisted of an assistant engineer in charge and two field parties, each under the immediate direction of an assistant engineer, and consisting of one rodman, one caulker, three laborers, an auto engineman, and the necessary equipment including motor truck and Ford car for the engineer. The increase of force provided for is such as to provide two additional field parties to be under the direction of the same two field engineers.

The leaks located and repaired in general average 50,000 to 75,000 gal. per day, but in case of complaint it frequently becomes necessary to spend an immense amount of time on leaks of but a few gallons a day when all ordinary methods fail and in rare cases just the primitive method of digging is the only recourse.

Another class of leaks which are extremely difficult to locate are abandoned service pipes which frequently are closed by bending over and hammering the end of the pipe within the property lines to avoid the expense of street excavation necessary in properly shutting them off at the main. Here again all ordinary methods of waste detection fail due to the fact that on account of the usual length of service pipe little or no sound is produced which can be detected by aquaphones.

In one instance in last year's work the practical stripping of a 6-in. main became necessary and inadvertently to shut-in-d ings were made, the work terminating in the location of an abandoned service pipe discharging about 60,000 gal. per day. This flow was making its way underground in a northwesterly direction beneath cellars and areaways and appearing at the point of complaint in the next block. In this case the size of the leak was sufficient to have been easily located by the ordinary methods if it had occurred nearer to the street main but on account of the length of service pipe, with, undoubtedly practically full opening at the end, no noise was traceable by ordinary soundings.

The record of the work done in 1919 may be of interest as illustrating the frequency of the different classes of leaks. The leaks stopped totalled 9,348,000 gal. per day. The average size of the leaks located was 54,000 gal. per day. The number in the different classes was as follows:

Live services	8[illegible]
Abandoned services	1[illegible]
Blown joints	63
Leaking valves	[illegible]
Cracked pipe	1
Total number of leaks	173

Experiences with Pipe Jointing Compounds

Interesting information on experiences with various kinds of pipe jointing compounds was brought out in a paper and the subsequent discussion before the New England Waterworks Association. The paper was presented March 10 by Fred O. Stevens, Engineer and Superintendent of Waterworks. The paper and discussion are printed in the June Journal of the association, from which the matter following is abstracted.

*Experiences With Lead Hydro-Tite Joints.—The writer has used the two substitutes for lead known as "Leadite" and "Lead-Hydro-Tite" for over 8 years, in various localities and under varying conditions, with very satisfactory results, and as a consequence has acquired a great degree of confidence in them.

In the summer of 1917 the Weymouth waterworks laid 3,400 ft. of 8-in. pipe, from which no services were taken until the following season. The joints were of Lead-Hydro-Tite, and the new gate controlling this line was by-passed with a ⅝-in. Empire meter testing 99 per cent in 1/32-in. opening. For the final measurements the flow was too small for accurate measurement by meter, and a force pump was used, pumping from a pail into which water was fed by a standard gallon measure. The results as to leakage per linear foot of joint are shown in the following table, and would, according to available data on the subject, be considered excellent for lead joints:

Date	Section.	No. Joints	Gal. per Minute.	Gal. per 24 Hrs. per Lin. ft. of Joint	
1917.					
July 26	1	75	3.375	26.20	New joints.
*Aug. 8	1	75	.150	1.16	
Aug. 20	2	180	.322	1.01	Sec. 1 plus 105 new joints
Aug. 25	2	180	.305	.99	
Sep. 2[illegible]	2	180	.217	.70	
Nov. 2	1	75	.011	.32	
Nov. 2	2	180	.098	.32	
Nov. "	3	250	.145	1.15	Sec. 2 plus 70 new joints
Nov. 2	4	337	3.500	6.16	Sec. 3 plus 85 new joints or entire extension.
1918.					
*June 1	4	33[illegible]	1.0	.26	

Pipe was 8-in. Class E, New England weights. Average pressure, 70 lbs.

Leakage measured by ⅝-in. Empire meter, registering 99 per cent on 1/32 in. opening at 70-lb. gage pressure.

*By pump and gallon measure.

This work was done by a man having one season's experience with Leadite, exercising the ordinary degree of care usually required by the writer on this class of work, and the results should give a fair indication of the degree of tightness to be expected under average conditions.

As to the matter of joints blowing out, the writer can only

---

*From paper by Fred O. Stevens.

say that he has never known of a Leadite or Hydro-Tite joint blowing out. In fact, the strength of these materials and their adhesions to the metal as demonstrated when a joint is dug out seems to be sufficient evidence of their value in this direction without extensive experiment.

As to the behavior of this type of joint when subject to crushing stresses such as occur when portions of a pipe line are left unsupported by the settlement of backfilling, the writer has been until very recently, in doubt, in fact, uncertainty on this one point has prevented him from giving these materials his unqualified endorsement as substitutes for lead. This doubt has been pretty much dispelled by the results in a case that has recently come to his attention.

The Berlin Water Co., of Berlin, N. H., built last year a new dam from which an 18-in. cast iron main was led to the city distribution system. About two lengths of this pipe were in the dam, and on the end of the first length on the down-stream side an 18-in. valve was placed. Joints were all of Lead Hydro-Tite. Before any more pipe was laid the reservoir was filled, and some time later a washout occurred which completely undermined this length of pipe, leaving it and the gate suspended in the air and supported solely by the material in the joint near the masonry. Just what the maximum stresses were in the joint it is neither easy nor necessary to compute, but it seems to the writer that they are as great as are apt to be encountered under ordinary working conditions.

***Experiences at St. Louis With Leadite and Metallium.**—The St. Louis Water Division has on several occasions tried other materials than lead for making cast-iron pipe joints. During the year 1913 a line of 6-in. pipe was laid in Fair Grounds Park, a connection being made to the city main in Natural Bridge Road, west of Grand Ave. The pressure at this point is approximately 35 lbs. The joints on this particular line were made with Leadite, and so far as reported have not given any trouble nor has the line required any maintenance since it was laid. The use of Leadite was purely an experiment and it was thought at the time, after trial, that it would not be easily adapted to local conditions.

Leadite is a material which requires a very definite heat for melting to proper consistency, and it was found difficult, if not impossible, to control the temperature by means of a coal fire built around a melting pot as was used on pipe-laying work at that time. The tendency seemed to be to have the fire too hot, which caused the Leadite to burn. Trouble was also experienced by the men pouring the joints, in that the fumes would rise from the pouring pot directly into the faces of the men. This condition seemed to be particularly bad by reason of the fact that the trench in which the pipe was laid was narrow and deeper than the ordinary trench for 6-in. pipe.

Unfortunately, no figures were kept on the cost, but there seems to be no doubt, but that if properly used by experienced men the cost could be reduced below the cost of the ordinary lead joint.

In 1918 about 1,200 ft. of 6-in. pipe was laid, the joint being poured from a new compound called "Metallium." After the pipe was laid the trench was left open for about two weeks to note the leakage, which was measured through a small meter. This leakage, immediately after the pipe was laid, amounted to 2½ gal. per minute, the average during the first 24 hours being 1.3 gal. per minute, which was reduced to an average of 1.15 gal. per minute during the second 24 hours. In the course of the two weeks before the trench was filled the leakage stopped altogether.

The last three lengths of pipe laid on this line were laid on a sharp up-grade, the rise being 3 ft. in 36 ft., the change in grade being made at one joint. Afterwards this pipe was lowered while under pressure and this joint was closely watched during the process of lowering, but no leakage was noticed and no damage to the joint was observed.

For 15 years milk of lime, at a temperature ranging from 80 to 130° F., was pumped through a 6-in. cast-iron pipe from the coagulant house to the delivery well, a distance of about 700 ft. A great deal of trouble was experienced with leaking joints caused by expansion and contraction. In 1919 a new line was laid with cement joints.

The joint was calked with yarn, as in a lead joint. Cement was mixed neat, rather dry, and tamped in the joints by means of a calking tool. The calking was carefully done, and continued until water came to the surface of the cement joint. The joint was continued on the outside by being built up to the outside diameter of the bell of the pipe and sloping down to the barrel of the pipe at an angle of about 45°. This was troweled to a smooth finish, neat cement also being used.

This line has been in service for several months, and has given no trouble on account of leaking joints.

The only leak that has occurred on the line was found on examination to be due to a transverse break in the pipe about 18 in. from a joint. The pipe was pulled completely in two, the nearest joint being entirely intact and uninjured. Evidently the break was due to contraction in the line caused by temperature change.

***†Experiences at Atlantic City, N. J., With Leadite.**—In the old days, when the Atlantic City Water Department was run by two different franchise holders, all joints were laid with lead, but about 1901 Mr. William C. Hawley, now in Wilkinsburgh, Pa., began the use of Leadite. He was followed by Mr. Allen, his successor, and by myself. We now lay with Leadite almost exclusively. We have had no difficulty in carrying pipe along trench lines, and as our contractors are not always careful, the pipe gets pretty heavy punishment. We have no difficulty with the Leadite joints. The first joints laid with Leadite, back in 1901, are still intact and do not show any signs of deterioration.

****Experiments at Boston With Leadite.**—Four lengths of 4-in. pipe and one short piece were jointed with Leadite, supported at three places—at each end and in the middle. The center support was removed and a deflection of 22 in. followed without leakage, with no sign of failure of the joints. We then proceeded to load the center of the pipe. At a load of 100 lb. no leakage had developed, when the pipe suddenly broke in two in the middle, at a point 18 in. distant from the nearest joint, and where a ⅝ tap had been taken out of the 4-in. pipe and plugged with a cast-iron plug. At the time of the break there was a total deflection of 25 in. The span from support to support was about 48 ft.

That encouraged me to use Leadite in laying pipe on a bridge across the Neponset River. This bridge carries heavy traffic, including two lines of heavy cars. The necessary location for our pipes was within approximately 4 ft. of one of the rails, and about 3 ft. lower, on a part of the bridge where it was subject to serious vibration. We used Leadite. That experiment is still in process. It has been there for five months now. When the line was put in we had leakage—not serious leakage, but continual dripping. Before the pipe was covered up in order to protect it from frost, that leakage had nearly ceased, and subsequent examinations appear to show that it has altogether ceased.

††Effect of Leadite Joints on Electric Thawing of Frozen Pipes.—In Boston, after our experience with frozen pipes during the winter of 1917-18, we realized our dependence upon electricity as a means of thawing. As we had been using Leadite somewhat and had arrived at a point where we intended to extend its use, it occurred to us as desirable to know whether or not Leadite joints prevented the passage of electricity on our pipe lines. As a means of answering that question we assembled on blocking in our yard a section of 4-in. cast-iron pipe about 50 ft. long, containing about seven joints. Caps were placed on both ends and water admitted to the pipe under pressure. Corporation cocks were placed in the line at points between the joints. Connections were made with these cocks and a storage battery of eight 2-volt cells connected in series. Volt meter, ampere meter, and other necessary apparatus were used, but not the slightest indication of a flow of current through the joints could be observed.

We then burned out the joints and re-made them, inserting in several a lead wedge about 2½ in. long, 2 in. wide, and ¼ in. thick. The wedge was placed in the bottom of the joint and driven in so as to make contact between the bell and spigot, and the Leadite poured around it. Electrical connections were made, and we found that a flow of current passed through every joint which contained a lead wedge, but not through those without it. We allowed the section of pipe to remain under pressure for two weeks, and upon again testing the joints electrically, we found the conditions to be the same. As to the amount of current flowing on the pipe, it varied from 1 ampere to 400, and from 14 volts to 30. This amount of voltage and amperage was made possible by using 16 cells in our battery. No bad effects were observed in the joints during the flow of 400 amperes other than the heating of the lead wedge to the point where it caused the surrounding Leadite to melt a very little. This could have been avoided by using a larger wedge. We next decided to make tests on pipes in the ground where we knew Leadite was used in the joints. We applied the current exactly as we would in an actual thawing job, with the following results.

---

*From the discussion of E. E. Wall, Water Commissioner, St. Louis, Mo.

*†From the discussion of Lincoln Van Gilder, Superintendent Water Works, Atlantic City, N. J.

**From the discussion of Frank A. McInnes, Engineer Public Works Department, Water Division, Boston, Mass.

††From the discussion of George H. Finneran, Superintendent Water Service, Boston, Mass.

At the intersection of M and Eighth Sts., where a 12-in. gate had recently been established on the Eighth St. line, four Leadite joints were used. By connecting our positive terminal with the service pipe in the house located in M at Eighth St., and our negative terminal with the pipe in the house located in Eighth at M St., the current traversed by way of the pipes about 50 ft. of ⅝-in. lead pipe with brass fittings, 72 ft. of 6-in. cast-iron pipe with lead joints, and 36 ft. of 12-in. cast-iron pipe with four Leadite joints and three 12-in. lead joints. Under these conditions a flow was obtained which our meters indicated as 110 amperes, 16 volts. The soil in the vicinity is clay. We could have increased the flow by increasing the voltage, but we considered that which we obtained sufficient.

In Dudley St. near Belden St., we made connections with the supplies to two houses 100 ft. apart. The Dudley St. main is 12 in. in diameter and jointed with lead except where a 12 by 6 hydrant branch had recently been inserted and Leadite used in the joints. This hydrant branch was located between the two services. By using 16 volts we obtained a flow of 87 amperes. Car tracks are laid in Dudley St., and at this point one of the rails is about 3 ft. from the line of our main pipe. By transferring our negative terminal from the service pipe to the car rail the flow increased to 100 amperes. In my opinion, this indicated that the current, after traversing the service pipe to which the positive terminal was attached and the main pipe as far as the Leadite joints, jumped from the main pipe to the rail and followed the rail to the negative terminal, thus indicating less resistance in the soil between the main and the rail than in the main and the Leadite joints. Our experience in electrical thawing is that the soil very often acts as a good conductor, and where a hydrant or service pipe was not conveniently located for contact with our negative terminal, and a car rail was laid in the street, we always used the car rail as the negative electrode with usually satisfactory results.

In Assabet St., Dorchester, where we laid 161 ft. of 8-in. main and established a post hydrant in 1910, using Leadite for joints, a flow of 215 amperes pushed by 16 volts was obtained between our two terminals. The positive terminal was connected with the sill cock of a house, and the negative terminal was in contact with a post hydrant. The distance between the two terminals by way of the pipes was about 160 ft., of which 123 ft. was 8-in. cast-iron pipe with Leadite joints, the remaining portion being 8-in. cast-iron pipe with lead joints, and ⅝-in. lead pipe with brass fittings. The ground was loam, quite moist, being at the bottom of a hill. Thinking that the soil might be a big factor in the flow, we cut out and removed from the ground a section of pipe containing a Leadite joint, and tested it for a flow from the bell to the spigot. We found a free flow, but upon further testing and closer inspection we discovered that the current traveled through a film or scale of what appeared to be rust which had accumulated on the face of the Leadite joint. When this scale was removed—and it required some vigorous cutting and scraping to remove it—the current ceased to flow. We then removed the Leadite from the joint and tested it for conductivity and found that the clean, uncombined Leadite would not carry current, but that combined with the scale which adhered to its surface it became a conductor through the medium of the scale.

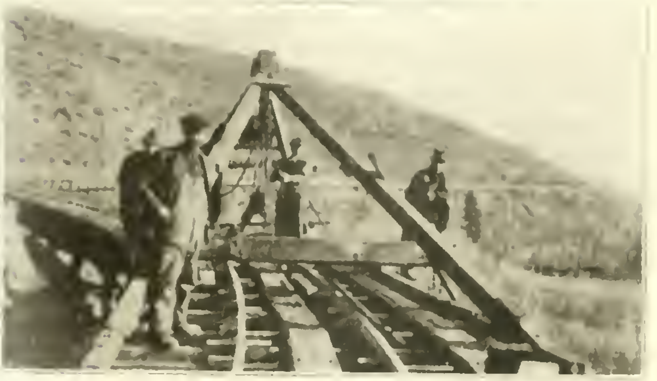
The conclusions arrived at through these and other experiments are that a Leadite joint by itself is a non-conductor of electricity; that cast-iron pipe lines with Leadite joints can be made to carry a current of electricity by the insertion in each joint of a metallic wedge, preferably of lead, of sufficient size and so placed between the bell and the spigot as to make good contact; that under certain conditions Leadite joints will not prevent the passage of a current of electricity along a cast-iron pipe line, as, for instance, where a body of rust is developed in the joint, the grains forming a path for the current from the spigot to the bell, or where the spigot butts against the hub, contact is made complete by the lodgment of rust between.

As a general statement, based upon conditions as they exist in Boston, it is safe to say that in almost every case the soil will act as a conductor and offer a path for the current either around the Leadite joints or in some other way to the negative terminal, and that the use of Leadite as a joint making material will not interfere with the use of electricity as a thawing agent.

Derrick Traveler for Raising Irrigation Flume to Grade

A novel means of raising a metal flume to grade was employed in the Cascade Irrigation District, New Ellensburg, Wash. The flume is supported on timber bents spaced 16 ft. C. to C., and resting on concrete pedestals, which extended materially above the ground when first built. However, earth slides have buried the pedestals and timber footings to a depth 1 ft. to 2 ft. This has resulted in rotting the timber, causing the flume to settle from ½ in. to 8 in.

The flume is in a very inaccessible place, and it was rather tedious to jack up each bent from below, and block up to grade. To overcome this slow process a four-legged derrick was devised by W. T. Bowman, engineer of the district. This derrick carried a 5-ton triplex chain block hitched at the apex, as shown in the accompanying illustration.


Special Derrick for Raising Flume.

The derrick fits in between the projecting rods of the flume and spans two panels. The chain is hitched to an 8x8, crossing the top of the flume, the ends of which are snubbed to each post of the bent, thereby exerting a direct lift on the bent.

When the flume was lifted to grade, the rotten ends, which in some cases were 2 ft. long, were sawed off and replaced by new ones, cut to fit and soaked in tar to keep the end legs of the derrick rigidly spread, two longitudinal struts, hinged in the middle where they carry over the bent to be raised, allow flexibility in going around curves and in raising the bent. Also, to keep the legs from spreading, two cables parallel the struts.

The work was described in the Highway Magazine, to which we are indebted for our information and the illustration.

The A. A. E. to Have Industrial Department. An Industrial Department, long contemplated by the American Association of Engineers, has now formally been authorized by the Board of Directors of the Association. Steps are under way to organize this department and take up consideration of the problems of mechanical, electrical and chemical engineers in industrial work. A. M. Cornell, chief engineer of the Pettibone & Mulliken Co., Chicago, will supervise the activities of the department until such time as the duties warrant the employment of a full-time paid secretary. Funds will be raised by setting aside $2.50 out of the entrance fee accompanying applications obtained by members in industrial work, or sent in by applicants working in industrial plants. This is the same plan used in building up the Railroad Department and the Federal Department.

Experience of Montreal Water & Power Co. in Manufacture of Filter Alum

The Montreal Water & Power Co. of Montreal, Que., for the past four years has been operating a plant for the manufacture of alum by the Hoover process. In a paper presented last month at the Montreal convention of the American Waterworks Association, Mr. Jas. O. Meadows, Sanitary Engineer, Montreal, describes results obtained at the Montreal plant. An abstract of the paper follows:

The alum plant of the Montreal Water & Power Co. was installed with the idea of keeping the capital outlay as low as possible consistent with proper operation, because at the time it was thought that such a plant would be used for only a comparatively short period of time.

The plant consists of an acid storage tank, a dilute acid tank, bauxite weighing hopper, Stedman mixer, and concrete crystallizing tray. No crusher is provided, the filter alum being broken up into lumps of suitable size by hand sledges.

Method of Manufacture. The manufacture of Hoover process filter alum is simple, but like every simple thing, there are several necessary conditions that need to be carried out to secure the product desired. By varying the temperature of the dilute acid, the character of the alum can be modified. During the winter months a porous alum is desired, because of its greater solubility, and this product can be obtained by mixing the bauxite with a low temperature acid. During the remainder of the year a filter alum of a more dense texture is secured by using a higher temperature acid.

The temperature of the crystallizing tray floor is also a factor to be considered, and it is necessary to use a higher temperature acid for Monday's batch because of the lower temperature of the tray floor after the Sunday rest. The temperature of the acid is controlled by agitating with compressed air and with a cooling coil placed at the bottom of the lead-lined dilute acid tank. By using the air and cooling coil for different periods of time a dilute acid of the desired temperature can be obtained.

In securing a uniform product from day to day, care must be taken in having the acid strength uniform, the temperature variations slight, and the weight of the bauxite charge correct. The analytical work necessary to control the operation of the alum manufacturing plant consists of the analysis of the bauxite, acid and finished product, and the taking of the specific gravity and temperature of the dilute acid before a batch of filter alum is made.

A batch of alum (approximately 7,600 lb.) is made in five mixes using about one fifth of the material for each mix, and the time consumed in mixing a batch of alum is about three-quarters of an hour. Greater speed in mixing could have been obtained if a mixing pan with a deeper pan and two agitators had been installed; also a better mixture of the bauxite and acid could have been obtained. The batch of alum is usually made early in the afternoon, and by next morning the alum cake is ready to be removed from the crystallizing tray. Before the mixture of bauxite and acid is dumped into the tray the fine alum dust remaining in the tray is swept up into a ridge extending directly across the tray and to a height of about 2½ in. When the alum cake is to be removed from the tray, work is started at the alum dust ridge, as this point offers an easy place to pry the slabs of alum from the tray floor. The alum cake is removed from the floor with bars and picks and is broken up with hand sledges. The whole process, including carting to the storage floor above, consuming about six hours.

Cost of Production. Records of the alum making plant for the past two fiscal years ending May 1 last have been taken off, as during this period the cost of bauxite and acid has been rather constant, and it was thought that data covering this period would be fairly representative of present conditions.

The cost of production for this 2-year period is as follows:

Bauxite and acid (including freight and cartage)	$45,961
Wages	1,220
Maintenance	1,490
Interest and depreciation [illegible]	2,400
Total	$51,071

During this 2-year period 1,785 tons of filter alum have been produced, making the cost work out at $28.61 per ton. The market price of commercial filter alum (including freight and duty) during this period has been about $55 per ton f.o.b., Montreal, and based on this figure the alum-making plant has shown a saving of slightly more than $49,000 for the 2-year period. During this time, bauxite has cost approximately $24 per ton and 66° Baume sulphuric acid $26 per ton. At places where these two materials can be purchased at a lower figure the cost per ton for filter alum will also be correspondingly lower, because from the cost data presented it will be noted that the cost of bauxite and acid makes up 85 per cent of the total cost.

Advantages of Manufacture at Point of Consumption.—In the manufacturing of filter alum at the point of consumption, freight, bagging and cartage is saved on the water, which makes up about 20 per cent of the finished product. Experience over a considerable period has shown that the weight of the filter alum produced is practically the same as the combined weight of the materials that go to make up the product.

At the company's water purification plant the alum solution is pumped into the orifice box and from this point flows by gravity to the point of discharge. Since Hoover process filter alum has been used, greater depreciation of the solution pumps, valves, and fittings has taken place, due to the nature of the insoluble matter contained in the alum solution. This depreciation, however, has not been excessive, and has not run into an appreciable figure.

The manufacture of Hoover process filter alum has proved successful for the Montreal Water & Power Co. because of the saving effected. A further advantage is also gained as sulphuric acid is produced within a short radius of Montreal, and is easily obtainable, leaving only the bauxite to be secured from a distance. When secured, each ton of bauxite in storage represents about three tons of the finished product.

Roughness Coefficient for Dredged Drainage Ditches

Kutter's formula is generally accepted by engineers as being the most satisfactory formula in use for computing the flow of water in open channels. The results obtained by the use of this formula are, however, effected to such a degree by the coefficient of roughness, n, that the selection of the correct value of this factor is a matter of the highest importance. For the purpose of determining just what values of n properly apply to the various conditions of channel the U. S. Bureau of Public Records has made a series of experiments to determine the flow of water in dredged drainage channels. The experiments were conducted in six different localities and the results have been set forth in a professional paper, issued June 7, by the U. S. Department of Agriculture, as Bulletin No. 832. The notes following are abstracted from the bulletin:

Variation of n With Stage in Channel.—The results of these experiments show that generally the value of n decreases as the stage in the channel increases. This was pointed out in an article in the Engineering News, February 24, 1916, by R. E. Horton, as being true for natural river channels and was attributed to the fact that:

> In determining the coefficients of roughness in natural river channels the entire cross section as determined by soundings is taken into account, whereas if the cross section is irregular there may be pockets or holes in the bed of the stream containing slack water at lower stages, so that the full area of section is not effective. Similarly at low stages of the stream there is likely to be more or less fall that is not effective as slope and that does not contribute to producing velocity.

While the above is also generally true for dredged channels, yet the Bureau of Roads experiments show a great many exceptions, one of which is, where the values of n obtained were practically the same for all stages in the channel, owing to the fact that there was no appreciable amount of ineffective slope or cross-section and practically no difference in the degree of roughness of the channel for different stages. In another case, which shows the very reverse of the general statement above, n increased for an increase of stage. This was due to the excellent condition of the lower part of the channel as compared with that of the upper part.

Application of Results of Experiments.—It is impossible to describe with absolute accuracy the conditions existing in a channel, such as degree of regularity, amount and nature of obstructions and vegetation, and uniformity of cross section. Consequently it is impossible to formulate definite rules to govern one in choosing the proper value of n for any particular channel. It is believed that the views shown in the bulletin, together with complete descriptions of channels for which the values of n have been determined afford the best means of arriving at the proper value of n to employ for any particular channel. This applies especially to existing channels where it is desired to ascertain the capacity.

In order to determine the capacity of a proposed dredged channel it is necessary to assume the probable condition of channel. Values of n for dredged channels vary greatly, depending principally upon irregularities of side slopes and cross section due to erosion, caving banks or faulty construction, upon obstructions and growth in the channel due to lack of maintenance, and, under certain conditions, upon the effect of a lining of silt in the channel. In most cases where erosion takes place in a newly constructed and well finished dredged channel, the roughness coefficient increases, but the capacity of the channel as a rule also increases, since the enlarged cross section more than offsets the effect of the increased roughness coefficient. In some instances practically no difference in capacity in a newly dredged channel may result due to erosion, after a certain amount of erosion has taken place.

Conclusion from the Experiments.—A careful study of the results of these experiments suggests the following conclusions:

(1) That a deposit of slick, slimy silt on the sides and bottom of a channel greatly reduces frictional resistance to flow.

(2) That the clearing of perennial growth from a channel will greatly increase its capacity.

(3) That the growth of grass and weeds in a channel during the summer greatly decreases its capacity.

(4) That the accumulation of drift, trees, logs and other obstructions in a channel greatly decreases its capacity.

(5) That after a certain amount of erosion has taken place in a channel further erosion does not necessarily increase the roughness of the perimeter.

(6) That the roughness coefficient n is appreciably higher for a roughly dredged channel than for a smoothly dredged one.

(7) That ordinarily a dredged channel quickly deteriorates in hydraulic efficiency unless systematically maintained.

(8) That abrupt variations in cross section play an important part in reducing the hydraulic efficiency of a channel.

(9) That generally, in designing a proposed dredged channel, a value of n of 0.030 should be used if the channel is to be smoothly dredged, and of 0.035 if roughly dredged. If the above values are used the channels should be carefully maintained, and if not to be so maintained a value of n should be selected in accordance with the worst anticipated conditions for the channel. However, if it is known that such conditions will obtain as were found for some of the channels in western Iowa, a somewhat lower value of n may be used, depending upon the anticipated conditions of the channel.

(10) That in computing the capacity of an existing channel the value of n chosen whenever possible be based upon a comparison of the conditions in the existing channel with the conditions of channels for which values of n have been determined, such comparison being made, if not by actual inspection, at least with the aid of careful descriptions and views of the investigated channels.

Land Drainage in Illinois Under Proposed State Constitution.—The proposed new constitution of the state of Illinois contains provision for facilitating drainage projects which may mean the reclamation of 1,500,000 acres of river bottom land. New laws may now be made, according to the proposed constitutional provision, providing for straightening such channels, drainage and irrigation, and greater outlets for its drainage. Under the old constitution much drainage work was done, but the attempts in many instances were local and disproportionate to the task. Unequal districts worked on their particular parts of the same river valley without any co-ordination of purpose. The new constitutional provision would provide states supervision and appropriation from tax levies, so the reclamation of some of Illinois' richest land may be done systematically.

Compensation of Municipal Waterworks for Water Furnished City Departments

For many years the Board of Water Commissioners of Springfield, Mass., has recommended in its annual reports that the waterworks department be compensated for water and service furnished to the various governmental departments of the city. In its recently issued report for the year 1919 the Commission has the following to say regarding the matter of compensation:

"Besides the earnings derived from water furnished private consumers, the rate value imputed to the City for the various municipal purposes is credited on the books each year as accrued earnings, but no payment being made for same, the total amount has to be charged off annually as a 'bad debt.'

"The following tabulation in the usual form shows the distribution of the $72,377.60 representing such water service during 1919:

MUNICIPAL USE OF WATER, 1919

(Unmetered quantities in gallons estimated from amounts on basis of [illegible] cents per 1000 gallons, the equivalent of [illegible] cents per 100 cubic feet—per cent metered computed on quantities.)

Classification	Amounts	Gallons	Memo
Schools	$ 7,088.[illegible]	152,19[illegible],161	92.6% metered
Public buildings (except schools)	3,51[illegible]	1,887,426	88% metered
Public parks	1,7[illegible]	41,710,544	77% metered
Public playgrounds	118.00	2,211,280	Unmetered
Building purposes (streets and engineering departments)	266.20	1,082,000	Unmetered
Street flushing	1,100.00	16,500,000	Unmetered
Sewer department (flushing)	6,[illegible]16.00	94,8[illegible],020	Unmetered
Watering tanks and drinking fountains	645.35	9,655,100	84% metered
Total of above	$2[illegible],477.60	172,528,173	
Fire hydrant service	46,900.00	(Not reducible to quantities)	At $25 per hydrant
Total municipal use	$72,377.60	(As shown in Registrar's report.)	

"The Board of Water Commissioners does not wish to unduly press upon the City Council the oft repeated 'matter of compensation to the municipal water works utility for water and service furnished to the various governmental departments of the city,' as annually recommended in its reports for many years.

"Neither can the Board consider that its full duty to the people of Springfield has been discharged by refraining to urge its previous recommendations, or by ignoring this matter at the present time.

"It cannot feel otherwise than that its position is sound and fundamental, especially in view of the expressions from authoritative sources, such as are shown in the few following brief illustrations:

(Extract from recent letter from Mr. William J. Hagenah of Chicago—one of the leading public utility engineers and statisticians of this country—in commenting on the Springfield Water Commissioners' report for 1918.)

"I note with much interest the position taken by your board as set forth on pages 10 and 11 of the report, wherein it is urged that the city should compensate the water works for the services which it received. This position is so eminently sound from an economic and business standpoint that it does not admit of argument, and one naturally wonders why cities refrain from treating their utilities in a business-like manner. It is only by following this course that those who are giving their best efforts to the management of such properties can show the public the true results of their services. That certain departments of the city should make a heavy and expensive demand on the water works property without meeting the costs which they incur is unfair to the water works and would not be tolerated in any other line of business."

(Extract from opinion handed down by Public Utilities Commission of Maine.)

"Furnishing free water for municipal and fire protection purposes is unjust for the reason that the consumers are obliged to pay for privileges enjoyed by property owners, whereas the consumer should pay for the water he uses in proportion to his use, and the property owner should pay for his protection in proportion to the taxable value of his property."

(Extract from recent opinion by Public Service Commission of Pennsylvania relating to fire protection service furnished by a municipality.)

"No matter what system is adopted, the fundamental fact remains that this service must be paid for, either by the municipality itself through taxes or by those who use water, through rates. As an administrative policy we must provide for the payment for [illegible] to pay the just [illegible] performs for the [illegible] we are [illegible].

[illegible] to the Wisconsin Railroad Commission [illegible] plant as [illegible] the municipality itself, [illegible] If this policy is followed [illegible], at a reasonable rate for all service [illegible] to avoid unjust discrimination in favor [illegible] against consumers. The utility, in [illegible] to cover local taxes [illegible] in the property in order to avoid [illegible] in favor of the consumers as against the [illegible].

Many other similar expressions from expert authorities in [illegible] are available if needed.

Problems of Water Filtration*

By ABEL WOLMAN

[illegible] Engineer, Bureau of Sanitary Engineering, State of Maryland.

Systematic investigation in the field of water purification has progressed for a number of decades, but the study of problems has been, for the most part, intermittent, sporadic and disconnected. It should not be a difficult matter for the American Waterworks Association to plan the attack on a series of problems by the proper organization of a research committee. What are some of the problems which today remain to be solved? Although considerable advance in the practical methods of water purification has taken place in the United States, may we state definitely that the fundamental laws of coagulation, filtration and chlorination are accurately known? If so, are these laws applied in everyday operation? Some of us, perhaps, are not so sanguine about our complete understanding of the processes involved in the above mechanisms of purification.

The factors determining effective coagulation and sedimentation of waters differ in degree with different waters, but their characteristics in general are the same, regardless of the nature of the water. The effects of time, temperature, agitation, and hydrogen-ion concentration upon coagulation have been studied only superficially. The material for such study has been accumulated in a number of different fields in allied sciences, but has not yet been adapted to water purification problems. It is stated often, for example, that the formation of satisfactory floc is retarded by low temperature and by inadequate agitation, yet how many plants observe and record the nature of the floc produced each day, so as to provide the material for correlated study of its variations with other characteristics of the water during an entire year?

The measurement of floc formation in its various aspects, however, should be preceded by a study of the raw waters with a view to determining a more accurate and satisfactory method of apportioning coagulant to raw water to obtain satisfactory coagulation.

The usual method of turbidity reading with adjustments for rising, falling, constant, fine, medium, and coarse turbidities leaves much to be desired, particularly when frequently the usual procedure results in abandoning all methods other than adding chemical until the coagulation becomes satisfactory. These methods are necessarily wasteful, since for each water there exists a critical concentration of coagulant which is most effective and economical.

Can we not obtain a satisfactory index to the "coagulant demand" of a water by a simple test? When it is borne in mind that the coagulation of waters is dependent upon the nature and amount of the particles present it would appear that the search for such a measure should be in the field of colloid chemistry.

Another phase of the coagulation problem which has taken on new significance in recent years is the effect of the varying hydrogen-ion concentration upon flocculation. There apparently may be an optimum range of P_H within which the coagulation proceeds most satisfactorily. Water works operators and chemists should begin to accumulate complete data concerning the P_H values of different waters in the normal course of operation. In the State of Maryland we have been making for several months determinations of hydrogen-ion concentration on all waters and have instituted these tests as a daily procedure in several large filtration plants.

The study of sedimentation problems in the light of recent developments in physical chemistry may require some modifications of our older concepts. The effect of electrolytes, of competing and protective colloids, of surface tension and osmotic pressure are of more than purely scientific interest.

Recent work has demonstrated, for instance, that the Brownian movement is observed with practically every type of clay suspended in water, varying from the rapid motion of the finest particles to the more sluggish one of the larger particles or aggregates or when hampered by the presence of electrolytes.

The internal forces within a sand filter bed are of greater magnitude than is generally realized. Experience in Maryland with a number of peculiar phenomena in filter beds has disclosed a startling variety of forces released in filter beds, which appear to be intimately connected with the character of sand and of applied water. The appearance of internal contraction in a sand bed of such strength that the surface area of the bed may be reduced by more than 5 per cent of its original area is of importance in calling attention to the unsolved problems concealed within the bed.

Sanitarians have established definitely that waters may be made safe for potable purposes by chlorination. The waterworks official, however, must go a step further. He must make the water potable as well as safe. If the water is unpalatable and objectionable because of tastes and odors, then the problem of chlorination may not be considered as solved. It is only a few years since the conception of the mechanism of chlorine treatment has undergone some modification from the simple hypothesis of direct oxidation. But in this comparatively short period, a series of questions have arisen which are still imperfectly answered.

In this field again we must have recourse to highly technical investigations to aid us in clarifying our concepts of chlorination processes and in controlling their operation. Even today it is difficult to answer definitely whether the action of chlorine is physical, physico-chemical, or chemical, whether its action is selective for different types of bacteria and, if so, what the causes for such selection are. The action of other disinfectants is elective and their toxicity is dependent upon their position in definite ionic series and upon the characteristics of the different bacteria, such as their response to Gram stain. The surface character of different classes of bacteria show a marked influence upon their behavior under different conditions.

Where we attempt to treat raw waters of complex organic and inorganic content, our present methods of control are entirely empirical and not infrequently unsuccessful. The causes of tastes with low doses and the absence of tastes, at times, with excessive doses of chlorine are still in the category of the unknown. It is not a solution of the difficulty to state that tastes and odors may be prevented by proper regulation of applied chemical, for the terms "proper regulation" are indeed broad in interpretation. Proper chlorination control, on the contrary, would seem to be possible of attainment only after a complete understanding of the details of the complex disinfection processes has been reached.

---

*[illegible] Convention of the [illegible] Waterworks Association.

Waterworks in the Province of Quebec.—According to a paper by Theo. J. Lafrenière, Chief Sanitary Engineer of the Province of Quebec, in the June Journal of the Engineering Institute of Canada there are 440 waterworks in the Province, half of which are very small. However, 192 waterworks serve municipalities with a population of over 500, the combined population served being 1,383,700. The sources of water supplies in town of more than 500 population are:

Source of supply.	Number of works.	Population.	Per cent of total population.
Rivers	97	1,192,512	86.2
Lakes	20	52,879	3.8
Springs or wells	75	138,338	10.0
Total	192	1,383,700	100.00

The water obtained from lakes or springs is generally good; the water derived from the rivers requires purification. The supply of 86 per cent of the population using river water is filtered or chlorinated, but the supply of the remaining 14 per cent, representing 60 towns, will be difficult to improve, because the towns are small.

Method and Cost of Transferring Ashes by Sluicing

A method of sluicing ashes [illegible] in the new [illegible] station of the Denver Gas & Electric Light Co. of Denver, Colo., gives a handling cost of [illegible] per ton of ashes, or about 2 ct. per ton of coal fired. [illegible]

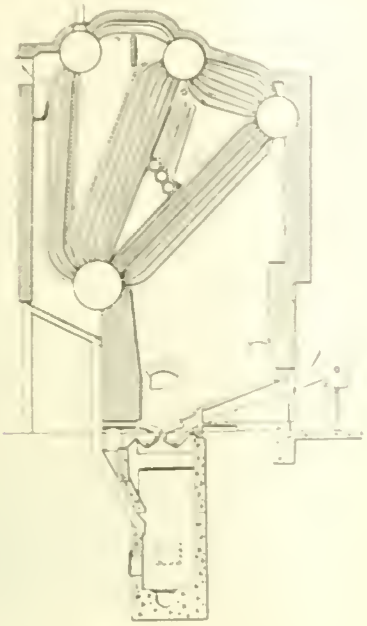


Fig. 1—Relative Position of Boiler and Sluiceway

by Alex W. Morgan in the Electrical World, to which we are indebted for the matter following:

The boiler and stoker equipment consists of four 750-HP. class D Connelly boilers equipped with Westinghouse 9-retort stokers and Westinghouse power dumps.

When ashes are dumped they drop directly upon "grizzlies" which will pass pieces of clinker up to 5 in. in the smallest dimension. All that will pass through the grizzlies is immediately picked up by the water and carried out to the ash sump. The clinkers which do not pass through are first cooled with water sprays and then broken up into pieces that will pass through the grizzlies. The water sprays, consisting of two 2-in. pipes, run the full length of each side of the ash hoppers. These pipes are drilled with ¼ in. holes spaced [illegible] and [illegible] is directed across the hopper [illegible].

Five [illegible] in the ash hopper [illegible] the grizzlies. One door is placed [illegible] and three others are equally spaced along the front [illegible]. These doors give sufficient working space to break up the largest clinkers.

The sluiceway is [illegible] in. wide at the top [illegible] deep, with a semicircular bottom and is built of concrete on a [illegible] per cent grade under all four boilers. Beyond the boilers the water enters a sewer tile [illegible] in. in diameter laid in the horizontal and discharges into the ash sump. No abrasion of the concrete has been noticed as yet.

The pumping equipment consists of a [illegible] open-runner centrifugal pump driven through a flexible coupling by a 25-HP. [illegible] phase [illegible] General Electric motor. This pump delivers about 1,[illegible] gal. per minute against a [illegible] ft. head and will wash out clinkers weighing up to [illegible] lb. The pump has an open runner and the water is recirculated.

The sluiceway discharges the ashes into a large hopper 19½ ft. wide by 26 ft. long by [illegible] ft. deep, from which they are taken by the grab bucket of the coal crane and loaded into railway cars.

At the present time the plant is burning 2[illegible] tons of coal per day and produces about [illegible] tons of ashes in 24 hours. Three combination men are required, one on each shift, to handle the ashes and look after the feed pumps. About one-third of each man's time is required to handle the ashes. The crane crew consists of two men on two shifts, and each shift spends about one hour removing ashes from the ash sump and loading them on the cars. The cost of handling ashes with this equipment is as follows:

One ash man, eight hours, at [illegible] per month	[illegible]
Crane crew, two hours at $1[illegible] per [illegible]	[illegible]
One 25-h.p. motor, 8 hours at $0.01 per kw.-hr.	[illegible]
One [illegible] motor, 2 hours at $0.01 per kw.-hr.	[illegible]
Total cost per day	$6.41
Cost per ton of ashes removed	$0.[illegible]
Cost per ton of coal fired	[illegible]

Florida Drainage Districts Cost $11,500,000. Organized drainage enterprises in Florida cover 1,366,526 acres, or 3.9 per cent of the total land area of the state, according to a preliminary announcement of the 14th census made by Sam L. Rogers, federal census director, at Washington. The total cost is given at $11,529,958. Florida's total land area is 35,111,040 acres. In the total area in organized drainage enterprises there are 114,512 acres of improved farm land and 424,783 acres of timbered and cutover land. There are 827,231 acres of unimproved land. Out of these 1,366,526 acres where drainage work is in progress, there are 617,508 acres of swampy or wet land subject to overflow.

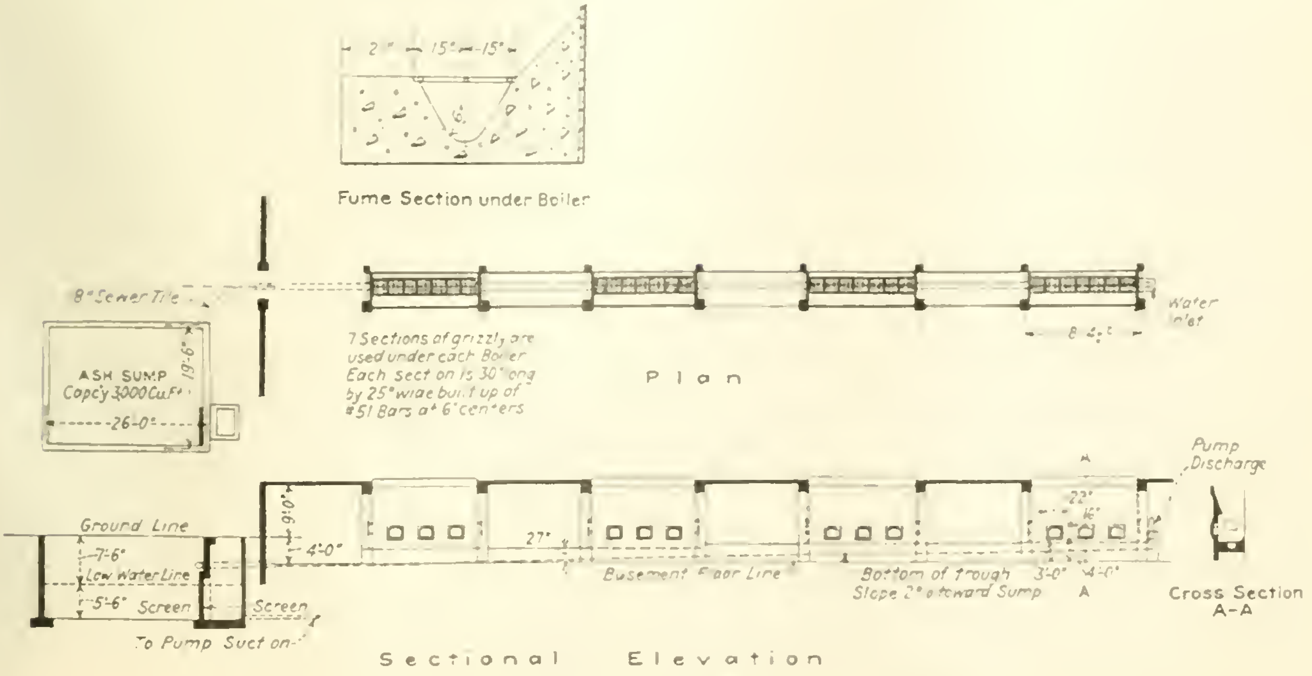


Fig. 2—Plan and Elevation of Sluiceway Under Boilers.

Bonus Systems for Meter Readers

[illegible] bonus systems for reading gas and electric meters [illegible] proving results. Similar application to the reading of water meters would produce equal results. The systems were described by the Committee on Bonus Systems of the Pasadena Convention of the National Electric Light Association.

Quantity Bonus System. Under this system the average number of meters read in a day has been increased over 50 per cent. This system was started in 1917 and the rates [illegible] have been $75 per month for a daily average of 250 meters, plus a bonus of 50 ct. for each increase [illegible] in the daily average above 250, the average to be [illegible] on the month's work and the maximum wage to be $100 per month. By this plan the daily average of 300 meters gives a bonus of $25, or the maximum wage of $100. The following deductions are made from the bonus: Fifty ct. for each per cent above 7 per cent on meters missed; 50 ct. for each error detected on rereading the meter.

The increase in the number of meters read in a month after the bonus was inaugurated is shown in the following table:

	No. of [illegible] Readers Employed	Meters Read by Regular Readers	Daily Average	Per Cent Missed First Call	Bonus Paid
[illegible] 1916*	8	25,464	192	5	*
[illegible] 1917	7	24,272	278	4	$ 70.50
[illegible] 1918	7	25,216	276	6	88.00
[illegible] 1919	7	27,679	316	7	125.00

* [illegible] not used.

While the salary of the meter readers has been increased approximately 100 per cent over 1916, this increase would, no doubt, owing to the greater cost of labor in general, have been necessary regardless of the adoption of a bonus plan. Under the present arrangement the regular meter readers do not, as a rule, read any meters missed at first call, but this work is done by two other men, who read "misses or skips" each morning and deliver bills in the afternoon. These men are at present paid a straight wage of approximately $75 per month. This arrangement was not in force during 1916, but has no effect on the previously reported daily average, which was and is now computed on the elapsed time for routes based on an 8-hour day. The rate of labor turnover and the number of errors in reading have been reduced under this bonus plan. It also has an effect in making easier handling of customers' accounts in the commercial office and in decreasing complaints.

The bonus applies on the combined total of gas and electric meters, but does not apply to five suburban routes that cover about twice the territory of the regular city routes. The regular city routes were analyzed as to distance covered and number of meters, and the division of routes was made as equal as possible among the various readers.

The "meter read" slip is so arranged that the meter reader is furnished with the previous month's reading only and does not have the consumption for months past to guide him in [illegible] "curbstone" readings. When a man is suspected of this practice a few dummy slips are inserted the next time he goes over a route. Only two readers (both [illegible]) have tried the practice, and they were quickly [illegible].

Piece Work Payment System. Under this plan the cost of reading a meter is only 1.3 ct., although it was 1.5 ct. six years ago when the readers were on a flat salary. This decrease has taken place in spite of the great general increase in labor costs since that time. Moreover, a better class of meter readers is now attracted. The plan is simply that meter readers (who read both gas and electric meters) [illegible] 1 ct. per meter read with a penalty of 10 ct. for [illegible] meter. If they are on special work or absent on [illegible] they are allowed $2 per day without any [illegible]. Their earnings average approximately $125 per month.

The Quality System. The third system, a "quality" plan, is based on the accuracy of the readings. By this plan the [illegible] read the meters every working day in the month and in addition to their regular salary receive a bonus depending upon the accuracy of their readings. A meter reader who is 100 per cent efficient, that is, whose readings are all correct, receives a bonus of $7.50 for the month. If his readings are from 98 to 99 per cent correct, he receives $6, and so on down to 90 per cent, as shown in the table:

Percentage of Meters Read Correctly.	Bonus per Month.	Percentage of Meters Read Correctly.	Bonus per Month.
100	$7.50	94-95	$4.00
98-99	6.00	92-93	3.00
96-97	5.00	90-91	2.00

If a meter reader after he has become familiar with the work falls below 90 per cent, he is replaced by a new man. In addition to this bonus the meter reader at the end of the year who has the highest rating receives an extra bonus of $25. To qualify for the month rating a meter reader must have worked three-quarters of the working days in the month. If a meter reader is late in reporting ten times during the month he is not eligible to participate in the rewards.

Benefits from Regulation of Stream Flow in St. Maurice River, Quebec

The Guoin Dam of the Quebec Streams Commission has been in service for over two years, including three winters. The benefits from this dam were outlined by Mr. Olivier Lefebré, Chief Engineer of the Commission, in a paper presented April 15 before the Montreal Branch of Engineering Institute of Canada.

The natural flow of the St. Maurice River had been measured at Shawinigan, by the Shawinigan Water & Power Co., and complete daily discharge records were available from the year 1900. They show that the average low water discharge was 6,000 second-feet. The lowest discharge recorded was 5,200 second-feet for about one week in March, 1901; the highest water recorded was 166,000 second-feet on May 6, 1904.

Duration curves plotted for the years 1900 to 1912 show that the natural flow was:

	Highest Year. Sec. Ft.	Lowest Year. Sec. Ft.	Average. Sec. Ft.
Seven months	24,500	9,000	13,200
Eight months	16,700	7,800	11,300
Nine months	14,300	7,400	9,800

The average yearly run-off from the watershed at that point for the period 1900-1912 was 21.3 in.—the maximum being supplied in 1907-08 when the depth was 26.9 in., and the minimum was recorded in the year 1906 at 15.33 in.

During the period of operation of the Gouin Dam the flow of the river has been maintained so that at no time the minimum at Shawinigan was below 12,000 second-feet. The water level in the reservoir is today 41 ft. above natural low water—that is to say, 6 ft. below the crest of the spillway. Last summer the water level reached 1322.25, or 2 ft. 9 in. below the top of the spillway.

The benefits to be derived from regulation were calculated from the flow curve of the year 1906, which was the lowest year for the period 1900 to 1912. From the records of that year, a duration curve was made and the amount of water necessary to make up the deficit for a minimum flow of 12,000 second-feet was easily arrived at. This water was being used at Shawinigan over a head of 150 ft., the number of horse-power figured at 80 per cent efficiency on the wheels, was deducted at low water. This number was close to 81,600 HP. for a short time, and the benefits were as the water required decreased. Distributed uniformly over the whole year, the benefits total 32,250 HP.

At Grand'Mère, where the water is being used under a head of 75 ft., the benefits will be exactly half of those of Shawinigan.

In order to ascertain that the amount of water available in the Gouin Reservoir would be sufficient for a regulation to 12,000 second-feet at Shawinigan, calculations were made since the latter part of April, 1913, when flow records were kept at the Gouin Dam. The amount of water measured at the dam site was taken as being the supply from the watershed. The amount of water required at Shawinigan to bring the flow up to 12,000 second-feet was taken as being the demand and, accordingly, a diagram was made showing two curves: one being the supply curve and the other the demand curve. The supply curve is made up of the amount of water which was measured at the dam; the demand curve is made up with the amount of water required at Shawinigan to maintain the minimum flow at 12,000 second-feet, after deducting the natural flow from the proposed reservoir, that is to say—supposing, for example, that the discharge at Shawinigan was 15,000 second-feet and that, on the same day, the discharge at the Gouin Dam station was 5,000 second-feet, it meant that the discharge of the St. Maurice River, outside of the reservoir, was 10,000 second-feet. In that particular case, and that the demand was 2,000 second-feet and the supply 5,000 second-feet. The daily discharge is easily computed into square-mile-feet by multiplying by 0.0031.

The Gouin Dam is located about 220 miles from Shawinigan, which is the point of regulation. The water let out from the dam does not reach Shawinigan until 10 to 12 days later—that is, its full effect is not felt until after 10 days in summertime and 12 days in wintertime. There must be a certain amount of loss by evaporation in this distance, and calculations were made entailing a loss of 25 per cent in the amount of water let out from the dam. Similar calculations were made for a regulation to 14,000 second-feet. The curves show that a regulation to 14,000 second-feet is possible, but should there be a loss of 25 per cent in the amount of water let out, the reservoir would not be sufficient.

The discharge of the river is controlled at three different points, namely, at Weymontachingue, 50 miles below the dam where a gaging station was established by the Shawinigan Water & Power Co. in 1915, and a flow curve determined for that point. A similar station was established by the same company at La Tuque, immediately below the falls, and a third station is that at Shawinigan. The water level at Weymontachingue and La Toque is recorded daily and the information wired to the office of the commission. Similar information is obtained from the Shawinigan Water & Power Co. regarding the conditions at Shawinigan and Grand'Mere. The points of control are also provided with rain gages and the commission also is informed of the amount of rainfall recorded. In this way, a pretty good idea may be had as to the period when it will be necessary to draw upon the storage.

Last winter, the run-off in the rivers of this Province was exceedingly low. In order to maintain a discharge of 12,000 second-feet at Shawinigan, it was necessary to supply from the Gouin Reservoir 10,000 second-feet during the month of March. In the past winter the reservoir level was lowered 4½ ft; during the winter of 1919, the flow was maintained at the regulated figure of 12,000 second-feet by lowering the reservoir level 3 ft.

Cost of Making Pipe Joints with Portland Cement

In a recent discussion of pipe jointing compounds before the New England Watertanks Association (June Journal of the Society) Mr. E. E. Wall, Water Commissioner of St. Louis, Mo., gives the following data on the construction of pipe joints made of portland cement.

Joints made of portland cement were used on about 800 ft. of 6-in. pipe line laid in 1917 to supply Camp Gaillard, a temporary recruiting station for a regiment of engineers, afterwards the 312 Engineers. From the 12-in. main for a distance of about 170 ft., the 6-in. pipe joints were made of lead, because the pipe was crossing a highway and also passed under the track of the water works railway, and it was assumed that any and all vibration or shock would be less liable to produce leaks with lead joints than with more rigid ones made of cement.

The cement joints were made by employees who had formerly had experience in such work for the gas company, who have laid all of their smaller mains in St. Louis for years with cement joints.

No leaks developed, and the joints showed no deterioration or checking when the line was taken up a year later. The water pressure ranged from 90 to 120 lb. per square inch.

It was found that one bag of cement made 18 joints and each joint required twice as much jute as a lead joint. Three men fixed and made 8 joints per hour.

Two men can attend to lead pot, make rolls, run and calk ten 6-in. joints per hour.

The actual cost of making 66 joints of cement in 1917 was:

4 sacks cement at 43¾ ct.	$ 1.75
16½ days' labor at $2.42	39.93
8¼ days' labor at $2.10	17.32
82½ lb. jute at 8 ct.	6.60
	$65.60

Cost per joint, 98 ct. Cost per lineal foot of pipe, 8½ ct.

The National Board of Fire Underwriters' Method of Grading Cities on Fire Service*

By CLARENCE GOLDSMITH

In the formulation of the standards for the different items, not only the data collected by the Committee on Fire Protection and Engineering Standard in connection with its inspection work, but the standards commonly accepted by municipal and consulting engineers, when such had been established, were considered. These standards, once established, apply in all cases, there being no separate standard for a small town and another for a large city. The fire defenses of a city are considered under the following main subjects: Water Supply, Fire Department, Fire Alarm, Police, Building Laws, Hazards, including those of lighting, heating, explosives, or inflammables, and Structural Conditions.

Suitable deficiencies are applied for each item under these several subjects. When the individual city is graded, an additional deficiency is applied when the climatic conditions such as wind, snowfall, cold weather, and hot, dry weather vary from the normal conditions throughout the country; and further provision is made for making an additional charge when there is a material divergence in the class of the fire department and the class of the water supply. It is manifest that where protection is furnished by a most excellent water supply and the fire department is seriously weak in men or equipment, that the full value of the water supply cannot be utilized in fighting fire, neither could a fully manned and well equipped fire department operate at its maximum efficiency if the water supply was seriously deficient. The relative values of points assigned to the several subjects were carefully weighed and considered. The number of points assigned to Water Supply when the city is on the engine stream basis is 1,700 and when on a hydrant hose stream basis 2,000 points; to Fire Department, when the city is on the engine stream basis 1,500, and when on a hydrant hose stream basis 1,200 points, Fire Alarm, 550; Police, 50; Building Laws, 200; Hazards, 300, and Structural Conditions 700 points.

This Association being more particularly interested in the Water Supply section of the schedule, the 32 items thereunder considered will be discussed in detail. These items are divided into three main classes, dealing with organization, adequacy and reliability, respectively.

Tenure of Office of Waterworks Employees.—In order that a system may be efficiently operated the tenure of office of all employes should be secure. In municipally owned works this can best be assured by civil service rules, properly administered. Civil service does not secure ideal conditions, but in general is found to be the most satisfactory means of precluding political influence, the object to be obtained is long tenure of office and an efficient organization.

The chief executive, who may be called either the superintendent or chief engineer, should be qualified by experience and education to efficiently fill the office. A competent executive, although without extensive experience in waterworks engineering, when associated with experienced engineers, frequently secures satisfactory results particularly in the direction of the larger systems.

Accurate and Complete Records Necessary.—In order to efficiently operate and economically design for future growth, it is necessary to have accurate and complete records; these should include a skeleton plan showing the general location of mains, gates, hydrants, reservoirs, standpipes, pumping stations and other works connected with the system, preferably on a scale of from 600 to 1000 feet to one inch. The sizes of mains up to 8 inches in diameter may well be indicated by symbolic lines and those of larger sizes by figures. When the larger mains are drawn with heavier lines than the others the map will give a comprehensive idea of the arterial system. All closed valves including those along service limits should be clearly indicated. Where the information is available, contour lines at convenient intervals should be added to the map; where these are not available, the known elevations should be put on in figures, and in any case, the exact elevations of the flow lines of all storage basins should be given.

---

*From a paper read March 21 before a joint meeting of The Associated Engineering Societies of St. Louis.

The exact location of mains, gates, hydrants, and larger service connections and where desirable all service connections should be shown in detail on sectional sheets on a [illegible] to 1 in. Where mains are not connected at street intersections this should be clearly shown and it is desirable to note on these sheets the date when the mains were laid.

For the operators of the distribution system one or more [illegible] valve location books should be provided. These should show sufficiently in detail to permit of intelligent operation of valves at complicated street intersections, and the location of the valves on large service connections should be included. A card index of valves should be kept showing location, make, type, size, direction and number of turns to open, depth below street surface, date set and all other necessary detail. A sketch showing the diagrammatic location of the valve with the ties may be placed on the reverse side of the card. Records should be kept of all repairs, inspections and operation of each valve; these may be in separate form or combined with card index.

Hydrant data including location, date of installation, make, type, number and diameter of outlets, diameter of barrel, valve and branch, direction of opening, whether there is a gate on the branch, and other necessary information should be kept in card index form. Each hydrant should be given a serial number, and records of inspection, condition, and repairs should be kept either separately or on the cards.

Each service connection should be assigned a number and all data including street number of property served, date of installation, kind and size of corporation and curb cock, pipe, curb box, and stop and waste and meter, if provided, should be in card index form; a sketch showing location may be provided on the back of the card.

Consumption records should be kept in such form that the average daily consumption for each year, month and week, and the maximum weekly, daily and hourly consumption can be readily obtained. This can be most readily accomplished by use of a meter of the Venturi type having a continuous recording mechanism, although moderately accurate results can be compiled from the pump plunger displacement by making proper allowance for slip. Where reservoirs and standpipes are in service, records should be kept of water levels, preferably by continuous recording devices. Complete records of pumping plant operation should be maintained in accordance with the prevailing modern practice. Continuous recording pressure gauges should be maintained. One should be located in the principal mercantile district and others at such points as may be desirable.

The department should have a crew available at all times on short notice to handle emergency work and a motor vehicle equipped with tools should be available. At least one responsible employe should respond to fire alarm in mercantile districts and to second alarms elsewhere.

Fire alarms should be received in some quarters of the department and in all direct pumpage systems at the pumping station. Where pressures are raised, or pumps are started upon receipt of fire alarms, fire alarms should be transmitted to the pumping station over duplicate fire alarm circuits. The foregoing standards of organization should [illegible] efficient operation of the system.

Requirements of Water System for Fire Service.—In considering the adequacy and reliability of a system, it should be kept in mind that the function to be performed is to furnish domestic consumption and to get water on the fire. In order to determine the adequacy of the source of supply [illegible] must first be determined. The records should show the average daily rate of domestic consumption and the maximum water consumed during any day within [illegible] years. In estimating the required fire flow, [illegible] for probable loss from broken connections and hydrants left open incidental to a large fire. Including this quantity, the total fire flow may be determined by [illegible] $G = 1020 \sqrt{P} (1 - 0.01 \sqrt{P})$, where G = gallons per minute and P = population in thousands. In all [illegible] given to the structural conditions [illegible] and also to the number of companies [illegible] and the outside aid that would be available in case of a large fire. Illustrative of the application [illegible] gals. a minute is required [illegible] mercantile district [illegible] of [illegible] and 12,000 gals. a minute [illegible] 200,000, cities having a population of over 200,000 require an additional 2,000 to 8,000 gals. per minute for a second fire.

Where fire engines are depended upon, the ability of the system to deliver the engine supply at a pressure of 20 lbs. in the mains is considered the ultimate capacity of the system. This residual pressure in the mains is deemed necessary to overcome the frictional losses in suction hose, hydrants and hydrant branches, and to provide the necessary velocity head in order to deliver water to the fire engine in volume equal to its rated capacity.

The pressure on the mains when the fire draft is being made, which is required to develop direct hydrant hose streams, is dependent mainly upon the height of the buildings; 75 lb. pressure or more, depending upon the heights of buildings and engine capacity in service, is necessary in high value districts; 60 lbs. where buildings are not more than 3 stories high, and in closely built residential districts; and 50 lbs. in village mercantile districts where buildings do not exceed 2 stories and in thinly built residential sections. If the fire flow available at these pressures is in excess of the engine capacity available, plus 1-3 the required fire flow, or if there are no fire engines, the protection is considered as being on a hose stream basis, and the deficiencies in the water system to furnish the required quantity at the desired pressure are worked out, otherwise the deficiencies of the water system are based on the capacity of the system to deliver water at 20 pounds. The adequacy of the system is based upon all equipment and appurtenances being operated under normal conditions which obtain at time of fire.

The advantage of having pressures sufficient to deliver 10 per cent of the required fire flow as hydrant streams is recognized and where systems do not have this capacity an additional deficiency is applied in proportion to the number of pounds below the required pressure at which this quantity is available. Consideration is, however, given to the reliability of the source of supply, inasmuch as it may be influenced by droughts, floods, ice formations, silting-up or shifting of channels, physical condition of intakes, forest fires, danger from earthquakes and injury by physical means, and a deficiency is applied in proportion to the unreliability, bearing in mind that a total interruption of the supply is more serious than a reduction in the quantity available.

Now that the adequacy of the system has been determined, the question of reliability in respect to its ability to maintain its normal capacity under various conditions is considered. Records maintained over a number of years show that certain failures, which result in partially or completely interrupting the supply occur with sufficient frequency to merit consideration.

Pumps and Pumping Stations. The number and total capacity of the pumps should be sufficient to allow maximum domestic consumption and the required fire flow to be maintained when the two largest units are out of service. The quantity of water held in storage and available to supplement the out-put of the group of pumps under consideration is taken account of in calculating the deficiency. Where there are low-lift as well as service pumps, the reliability of each group is considered separately and a deficiency charge is made for each.

Suitable credit is given for emergency supplies, when available, in proportion as they offset the deficiencies of the several parts of system. The utilization of polluted supplies is not advocated and where such are available and have been used, credit is given for only one-half the points which these supplies decrease the deficiency of the system, because they will probably not be used until conflagration conditions have developed.

A sufficient number and total capacity of boilers should be provided to deliver the required capacity as previously determined with one-fourth the entire capacity, and in any case there should be one boiler in reserve. Where chimney capacity is ample, an overload of 50 per cent for return tubular, and 100 per cent for water tube boilers, over the marker's rating is allowed, and credit is given for available water held in storage. Normally, there must be sufficient boiler capacity kept under at least one-half the required steam pressure, to deliver full requirements, in connection with storage, for a period of 2 hours.

All equipment must be of a design suitable for the service, must be maintained in good condition, and operated by a competent force. Pumps of the following types when well designed and installed are assumed as approximately equal the advantage of each, if any, being in the order of their naming. Centrifugal or reciprocating pumps driven by steam engines; centrifugal or reciprocating pumps driven by electric motor (the generating station must meet the same requirements for reliability as those applied on pumping station); pumps operated by water power; centrifugal or reciprocating pumps operated by internal combustion engines.

The supply of fuel must be assured and at least 5 days' supply should be kept on hand; oil should be kept in underground storage. Where gas or oil supply is unreliable, provision should be made for the use of coal. Any deficiencies in water power should be offset by a second source of power held in reserve.

Steam, gas, oil and feed piping or electric transmission lines should be so arranged that the failure of any line or storage, the renewal of any valve, transformer, or oil or feed pump would not prevent maintaining in connection with storage maximum domestic consumption for 2 days and fire flow for 10 hours. In determining the unreliability of overhead electric lines consideration must be given to the character of poles and wires, and of country traversed, prevalence of high winds, sleet and snow storms, and facilities for making repairs. The use of the same transmission line from transformer or switchboard by other parties introduces an undesirable hazard.

Pumping stations and other portions of the plant should contain no combustible material in their construction, otherwise an automatic sprinkler equipment must be provided. In any case the station should be protected against exposures, and hydrants and inside standpipes with hose and chemical extinguishers should be provided. If pumping station is not fireproof, the several sections, particularly any with high potential generating or transforming equipment, should be separated by parapeted fire walls and openings protected by at least a single, standard, fire door or wire glass in metal frame. Electric wiring shall be installed in accordance with the National Electrical Code and all internal hazards such as oil and waste properly safeguarded.

Reliability of Supply Mains.—The effect of a break in any pipe or conduit line on which supply to the distribution system is dependent must be considered in determining the reliability of the supply mains. Aqueducts, of good design and of substantial construction, such as masonry or concreted steel when reliably installed, shall be considered sufficiently dependable as not to require duplication. In determining the failure which will result in the greatest reduction of the supply, all mains which deliver from the source of supply or of storage to the principal mercantile district must be considered; these will include suction or gravity lines to pumping stations, flow lines from reservoirs, force mains, as well as arterial feeders within the distribution system. In determining the effect of any break the storage available must be considered and in calculating the quantity available from such source it is assumed that five days will be required to make necessary repairs. In designing suction and discharge headers, piping at reservoirs and filters, by-passes and cross-connections, particular attention should be given to the feature of reliability. This feature is frequently overlooked and single failures result in complete or serious reduction in the supply, when little or no additional expense would have been involved to provide the necessary reliability.

Determinating Points of Deficiency.—In determining the points of deficiency for the preceding items which pertain to reliability, except for that covering pumping station buildings, it is recognized that the probability of large fires occurring while any portion of the works is out of service is not so great in the smaller cities and the points of deficiency are reduced 10 per cent for each 1,000 gal. fire flow required below 5,000 gal.

In addition to the effect produced by a single break the probability of such a break occurring must be considered. Cast iron, wrought iron, wood-stave, reinforced concrete, and masonry conduit have been found satisfactory in various places and under certain conditions, but account must be taken of the general condition. The service record should be taken into consideration in judging of the reliability of these lines, together with the probability of their failure at stream crossings and railroad crossings where physical injury might occur; it is preferable to have mains laid far enough apart so that they will not endanger each other. The mains should be cross-connected about once a mile and equipped with suitable valves and blow-offs to enable shut-offs and repairs to be made promptly. Such mains are considered moderately unreliable when the repair of one valve would result in the total interruption of the supply.

The deficiency of the arterial system is based upon the results of the fire flow tests and a general consideration of the arrangement of the large mains. These should be of sufficient size to deliver the required fire flow into the several districts in addition to the maximum daily consumption rate and so looped that no large area will be dependent upon a single main. In general, large mains should be so spaced that they will not be over 3,000 ft. apart.

The large mains should not be laid in filled ground and should have special construction at railroad crossings and near bridge abutments; cover must be sufficient to prevent freezing and at least 2 ft. is required to prevent injury from traffic. Gate valves should be set at intervals of not more than ¼ mile and where connections to the intersecting smaller mains are made with run-arounds fewer valves have to be closed in case of accident than where these connections are made with crosses.

Four-inch pipe does not have sufficient carrying capacity to furnish fire protection and a deficiency is applied in proportion to the percentage of this size of pipe in the system which supplies hydrants. Six-inch pipe is considered the minimum size satisfactory for hydrant supply in residential districts and only when closely gridironed with cross-connecting mains, 6 in. or larger in diameter at intervals not exceeding 600 ft. Where pressures are lower than about 40 lbs. a satisfactory supply cannot be obtained from 6-in. pipe except where the blocks are small. In high-value districts 10 or 12-in. pipes are required. It frequently happens that although the required quantity of water can be delivered in portions of the high value district there are other parts where, due to elevation or small pipes, this quantity cannot be obtained; a charge is made for this deficiency.

In the course of development of any system it is impossible to eliminate all dead ends but 8-in. pipe should be used where dead ends or poor gridironing is likely to exist for some time. A charge is made for dead ends and poor gridironing of 6-in. and smaller pipes and this charge is reduced in proportion to the pressure carried in excess of 20 lbs. where fire engines are depended upon and 60 lbs. where direct hydrant hose streams are used.

Design and Spacing of Hydrants.—In order that hydrants may not be put out of service in too large an area, or the carrying capacity of the distribution system seriously reduced, it is necessary to equip the distribution system with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system will necessitate the shutting from service of a length of pipe greater than 500 ft. in high-value districts, or greater than 800 ft. in other sections, and will not result in shutting down a main artery. All valves should be inspected yearly and the larger valves more frequently. If valves do not operate in a uniform direction the spindles should be replaced to secure uniformity.

Hydrants should be of such design that they can deliver 600 gals. a minute with a loss of not more than 2½ lbs. and a loss of not more than 5 lbs. between the street main and the outlet; four-inch hydrant branches are too small to accomplish this result. All hydrants should have at least 2½-in. outlets and where engines are used large suction connections should be provided. Hydrants should be so designed that they will remain closed when broken off; this is of particular importance because of the large number of such accidents due to the careless driving of motor vehicles. Flush hydrants, particularly where heavy snows are common, are undesirable and cisterns cannot be considered of proper type.

The distribution of hydrants is worthy of thorough study for any deficiency in number or uniformity in distribution prevents the required quantities being concentrated on a fire. Satisfactory distribution requires that two-thirds of the required fire flow be delivered on the fire through hose lines none exceeding 500 ft. in length when direct hydrant streams are depended upon, and none exceeding 600 ft. in length where engines are used. The linear spacing is not the true measure of distribution. This will be readily seen when the size of the block is considered; where blocks are 200 ft. square one hydrant at each street intersection gives an area served of 40,000 sq. ft. and a linear spacing of 200 ft., and [illegible] blocks are 700 square in order to get one hydrant for each [illegible] it is necessary to set hydrants each 120 feet along the streets on all sides of each block. From the [illegible] it is seen that where hydrant streams are depended upon more hydrants are needed than when engines are used, and in either case, the area served is dependent upon the [illegible] required. Where engine streams are used, the areas served per hydrant in square feet for required fire flows in gallons per minute are as follows:

[illegible]	120,000 sq. ft.
[illegible]	100,000 sq. ft.
[illegible]	85,000 sq. ft.
[illegible]	67,000 sq. ft.
[illegible]	48,000 sq. ft.
[illegible] g.p.m.	40,000 sq. ft.
Where direct hydrant hose streams are used:	
[illegible] g.p.m.	100,000 sq. ft.
[illegible] g.p.m.	85,000 sq. ft.
[illegible] g.p.m.	70,000 sq. ft.
[illegible] g.p.m. and over	40,000 sq. ft.

Hydrants should be inspected in the spring and fall of each year, after use at fires during freezing weather, and daily in high value districts during protracted periods of severe cold.

Hydrant branches on large mains should be equipped with gate valves and where the distribution system is not equipped with sufficient gates to comply with the requirements previously set forth, gates should be installed in the branches served by the smaller mains. It is generally more economical and at the same time is considered better practice to equip the smaller mains within the gridiron of the distribution system with a sufficient number of valves rather than to equip the hydrant branches with gates.

Percentage of Deficiency of Water System Determined by Inspection.—An inspection of the water system enables the percentage of deficiency of each part of the work to be determined in respect to the standard, and from the percentage thus determined a charge in points is made from a deficiency scale which has been prepared of the points of deficiency corresponding to the per cent of deficiency. It is obvious that the relative values of the items considered in the before enumerated standards are not equal, and their importance is properly weighted in points by multiplying the points found in the deficiency scale by a factor corresponding to their importance. For instance, a deficiency in adequacy of capacity of the system to furnish average consumption and fire flow is charged at two times deficiency scale while the deficiency to furnish maximum domestic consumption and fire flow is charged at only one-half deficiency scale.

Similar standards have been established to cover fire department, fire alarm and the remaining features of the fire defenses of a city. With these standards established and [illegible] applied in accordance with the schedule, the classification can be determined with accuracy approaching that [illegible] by measuring a distance with a steel tape. In other words the grading schedule has established a unit of measure by which fire defenses can be surveyed with accurate results.

Operating Details of Springfield, Mass., Filters.—Filtered water was delivered during 1919 to the city of Springfield, Mass., from the West Parish filters at a net cost of $5.96 per 1,000,000 gal. This cost covers operation and maintenance only of the filters. The filters were scraped 38 times, an average of 205 cu. yd. of sand being removed from each filter. This average is increased by the fact that all sand was removed and washed from two of the filter beds. The average filter run after scraping was 26 days. The average time run after raking was 29 days. The itemized cost of filtration per 1,000,000 gal. delivered to the city, according to the [illegible] report of the Board of Water Commissioners was:

	Labor.	Materials.
[illegible]	0.24	$0.21
[illegible]	1.15	.17
[illegible]	[illegible]	.21
[illegible]	1.17	.18
[illegible]	[illegible]	.65
[illegible]	[illegible]	.06
[illegible]	..	.16
Totals	[illegible]	$1.64

City Water Rates Doubled.—City water rates at North [illegible] have been increased 100 per cent, the new rates going into effect immediately following a report of the state utilities commission to city council some time ago. Flat rates have gone from $6 to $12, and a minimum charge of $1.20 a month is being made.

Installation and Maintenance of Trash Racks for Hydraulic Power Plants

Trash racks of hydro-electric developments are installed to protect the water turbines, governing apparatus and equipment of the plant. If improperly chosen or installed, they may fail when needed most; if not properly maintained, they may obstruct the flow of water and even shut down turbines. A brief discussion of this problem is contained in a recent issue of Power, from which the following notes are taken:

A common form consists of 1¼-in. round iron bars, set vertically, to the top and bottom of which are riveted flat iron bars about 4 in. wide and ⅜ to ½ in. thick. The circular bars are usually spaced about 4 in. apart. Another common form of rack is similar to the foregoing, except that the grids or vertical bars are from ⅜ to ½ in. wide transversely to the water flow and 3 to 4 in. thick in the direction of flow. The former type is invariably built up in a blacksmith shop; the latter is usually cast or forged in one part. The former is the cheaper and more easily made and repaired; the latter probably offers the maximum strength of rack with a minimum obstruction surface for restricting water flow.

A trash rack should be designed to offer maximum obstruction to débris and foreign matter brought down by the water and minimum resistance to the passage of water. These two requirements are somewhat antagonistic, a condition often solved by installing two racks, the inner one of finer grating, thus not only lessening the likelihood of obstruction of water taking place, but also facilitating cleaning. The space between grids or bars of a rack should depend upon the obstructions to be guarded against, the size of unit to be protected and the velocity of the incoming water and waterborne obstructions. Where ice jams and logs, turbulent water and wind are expected to be encountered, the racks should have ample strength, for grids that become bent together result in an obstructed passage between which invariably forms the nucleus for a blockade of vegetation.

A trash rack should be designed to give sufficient passage for water passing through it of the desired quantity without excessive loss of head. It is surprising what loss of effective head will actually occur when vegetation, wood and other materials clog the intake, a condition that assumes particular importance in low-head hydro-electric developments. Loss of efficiency and capacity always follows, and a unit may be shut down entirely from this cause.

Where much vegetation is to be dealt with, it is advisable to design the trash rack so that if it be obstructed equivalent to 40 per cent water restriction, the necessary flow of water is still possible.

Coarse stationary trash racks are usually cleaned by hand, using a rake on a pole or handle for this purpose. Sometimes a rake similar to a harrow is used, hung from chains by a hoist so as to permit of being lifted by one or two men. When two trash racks in series are employed, it is a good policy to make the inner or finer rack self cleaning. This is generally accomplished by one or more rake-like appliances installed upon link chains, which in turn are driven from a motor operated countershaft located on top of the intake structure. Some form of adjustable iron comb is installed on top of each bay to catch the trash brought up by the scrapers and drop it on the floor.

Trouble with the trash racks is often encountered on account of corrosion of the intake screens and racks. In some cases this sort of corrosion is very persistent and rapid, and, from report, no sort of paint has as yet been found that will remain an impervious covering for the metal for any great length of time.

About the best manner of delaying corrosion seems to be to paint all metal work with a heavy red-lead covering. Racks and screens should receive attention, and possibly repainting, once a year. Painting by hand is most tedious if done thoroughly and is often slighted. Time and paint may be saved and a better job done by employing a paint spraying outfit. The larger and greater the number of racks, the more advantageous a spraying outfit becomes. Before applying the paint, all metal work should be thoroughly cleaned by sand blast.

The writer has never seen galvanized-iron trash racks used, probably for the reason that racks are made up close to the job, and galvanizing is not readily [illegible] under such conditions. It is suggested that the contractors for the water turbines or other hydraulic apparatus might include the trash racks and furnish them galvanized, at least in a few cases as an experiment.

Many hydro-electric plants have been forced to curtail output, in some instances even being [illegible] to shut down temporarily, because of obstructed trash racks. Probably most hydro-electric plants have at some time suffered from loss of head because the trash racks [illegible] cleaned and kept on clogging as fast as they were [illegible].

Recent Bidding Prices on Sewer Construction

The accompanying tabulation shows the itemized bids received June 9 by the city of Fort Madison, Ia., for sewer improvements, for which Burns & McDonnell are consulting engineers. The prices are interesting not only on account of the size of the job, but also because the work involves the practical reconstruction of the existing sewer system. It would be interesting to compare these figures with the bids received for the original sewers. The bids and figures follow:

Item	[illegible]	Nat. Cont. Co., Davenport, Ia.*	[illegible] Co.	[illegible] Moline, Ill.
Furnishing and laying 8-in. standard sewer pipe	[illegible] lin. ft.	[illegible]	[illegible]	[illegible]
Furnishing and laying 10-in. standard sewer pipe	[illegible] lin. ft.	[illegible]	[illegible]	[illegible]
Furnishing and laying 12-in. standard sewer pipe	[illegible] lin. ft.	[illegible]	[illegible]	1.[illegible]
Furnishing and laying 15-in. standard sewer pipe	[illegible] lin. ft.	1.10	1.2[illegible]	1.[illegible]
Furnishing and laying 18-in. standard sewer pipe	[illegible] lin. ft.	1.[illegible]	1.37	1.[illegible]
Furnishing and laying 15-in. D. S. sewer pipe	[illegible]15 lin. ft.	1.[illegible]5	1.2[illegible]	1.[illegible]
Furnishing and laying 18-in. D. S. sewer pipe	[illegible] lin. ft.	1.60	1.6[illegible]	1.75
Furnishing and laying 24-in. D. S. sewer pipe	[illegible]83 lin. ft.	2.[illegible]6	2.81	2.[illegible]
Excavating and refilling trench, 0 to 6 ft.	[illegible] lin. ft.	1.00	1.13	1.05
Excavating and refilling trench, 6 to 8 ft.	[illegible] lin. ft.	1.10	1.37	1.[illegible]
Excavating and refilling trench, 8 to 10 ft.	[illegible] lin. ft.	1.3[illegible]	1.6[illegible]	1.[illegible]
Excavating and refilling trench, 10 to 12 ft.	[illegible] lin. ft.	2.25	2.06	[illegible]
Excavating and refilling trench, 12 to 14 ft.	[illegible] lin. ft.	3.00	2.85	2.80
Excavating and refilling trench, 14 to 16 ft.	[illegible] lin. ft.	4.50	4.06	4.[illegible]
Excavating and refilling trench, 16 to 20 ft.	[illegible] lin. ft.	7.60	6.85	6.8[illegible]
Excavating and refilling trench, 20 to 24 ft.	[illegible] lin. ft.	10.00	8.85	8.8[illegible]
6-in. on 8-in. standard Y-connection	[illegible]	.9[illegible]	.93	1.00
6-in. on 10-in. standard Y-connection	[illegible]	1.25	1.23	1.25
6-in. on 12-in. standard Y-connection	[illegible]	1.65	1.57	1.50
6-in. on 15-in. standard Y-connection	[illegible]	2.25	2.4[illegible]	2.50
6-in. on 18-in. standard Y-connection	[illegible]	3.00	2.90	[illegible].00
6-in. on 15-in. D. S. Y-connection	[illegible]	2.75	2.8[illegible]	3.00
6-in. on 18-in. D. S. Y-connection	[illegible]	3.50	3.95	4.00
6-in. on 24-in. D. S. Y-connection	[illegible]	6.00	6.60	6.00
Furnishing and laying 6-in. C. I. pipe, Class "A"	[illegible] lin. ft.	4.50	4.20	4.00
Furnishing and laying 8-in. C. I. pipe, Class "B"	[illegible] lin. ft.	7.50	6.85	6.00
Furnishing and laying 14-in. C. I. pipe, Class "B"	[illegible]6 lin. ft.	12.10	11.85	10.00
Furnishing and laying 24-in. C. I. pipe, Class "B"	12 lin. ft.	16.00	19.50	20.00
Manholes	[illegible]	100.00	103.00	100.00
Lampholes	[illegible]	38.00	39.00	40.00
Flush tanks	7	150.00	165.00	150.00
Old manholes converted into flush tanks	[illegible]	75.00	78.00	80.00
Old outlets converted into lampholes	[illegible]	29.00	29.00	25.00
Brick paving, concrete base	[illegible] sq. yd.	5.15	5.[illegible]0	6.00
Two-course brick paving	[illegible] sq. yd.	5.00	5.63	7.50
Macadam paving	[illegible] sq. yd.	3.15	3.45	3.50
Concrete paving	170 sq. yd.	3.50	4.45	4.50
Class "B" concrete	[illegible] sq. yd.	25.50	2[illegible].00	28.00
Lumber in trench B.M.	[illegible] ft.	95.00	100.00	110.00
½-ft. Connection installed complete	[illegible] lin. ft.	.90	1.00	[illegible]
¾-ft. Connection installed complete	[illegible] lin. ft.	1.0[illegible]	1.10	1.15
Bluff street ejector station as per plans		7,646.00	10,445.00	10,000.00
Miller street ejector station		17,244	23,200.00	23,[illegible]00.00
Equipment at Bluff street station		6,550.00	6,420.00	6,500.00
Equipment at Miller street station		11,465.00	11,235.00	11,000.00
Bluff street station—Earth excavation	[illegible] cu. yd.	2.50	2.30	2.50
Bluff street station—Class "B" concrete	16 cu. yd.	30.00	30.00	[illegible]0.00
Miller street station—Earth excavation	[illegible] cu. yd.	2.75	2.30	2.50
Miller street station—Class "A" Concrete	[illegible] cu. yd.	35.00	35.00	30.00
Miller street station—Class "B" concrete	[illegible] cu. yd.	[illegible]	[illegible]	27.00
Miller street station—Reinforcing steel	[illegible] lb.	[illegible]	.10	[illegible]
Moving of ejector equipment		P F T	P F T	P F T
Total of bid		[illegible]	$520,671	[illegible]

*Awarded contract.

Portable Self Contained Outfit for Electric Thawing of Water Mains

A portable self-contained electric outfit for thawing frozen water pipes has been developed by the water department at Dedham, Mass. The outfit was described by Mr. [illegible] Gifford, Superintendent of Water Works, in a paper presented last week at a meeting of the New England Water Works Association. The following particulars are taken from the paper.

The apparatus is mounted on an old [illegible] truck which had been discarded by the fire department [illegible]. The truck is a 1914 model with four-cylinder motor rated at 24 HP, but giving an output of about [illegible] HP.

The engine is suspended below the frame and partly under the driving seat, the fly-wheel being located about [illegible] ft. to the rear of the seat.

A second-hand C & C generator was located, 2-pole, 125 volts, 16 kw. In its original form, this generator would develop more voltage and less amperage than desirable, particularly in making best use of the limited power available, and accordingly the windings were rearranged for [illegible] volts. In this connection, it was necessary to cut out the mica between every other segment and fill with copper. Doubling the width of the segments made it necessary to have brushes twice as thick as the old ones. Carbon brushes of sufficient thickness, made especially for this job, were tried, but it was not possible to develop any current with this type of brush. Copper brushes finally solved the problem. These were used by doubling up two commercial size brushes and making special brushholders.

The generator is mounted on a frame made from 2 in. by 8 in. hard pine planks and set with the pulley on the drive shaft directly over the fly-wheel of the engine. The fly-wheel and pulley are connected by means of an endless leather belt 5 in. wide. This belt hangs loose from the generator pulley when the engine is running idle or when truck is running between jobs.

The fly-wheel of this particular engine is 16 in. in diameter, and, having no means of determining how fast it was travel-

---

Increased Compensation for California State Engineers Recommended.—The report of the San Francisco Chapter of A. A. E. on the California State Civil Service has recommended that all engineering positions be freed from statutory limitation as to salary, and that with the exception of chief administrative officers, all engineers in state services be included under the provision of the civil service law. The chapter also condemns in some respects the sub-classification applying to engineering service and recommends a new one. Increased compensation is also advocated with a minimum for junior engineer of $1,800; for assistant engineer, $2,400; for senior assistant engineer, $4,000; for engineer, $5,000. No salary recommendations are made for chief engineer.

A. A. E. Has 19.554 Members.—At the close of business on July 8 the American Association of Engineers had 19,554 members.

[illegible] necessary to experiment, after getting connected [illegible] the proper size pulley for the generator. A [illegible] with [illegible] face was finally decided upon as [illegible].

[illegible] power to the generator when ready to begin [illegible] belt is tightened by means of an idler pulley [illegible] wooden slides connected by a screw operated [illegible] on the outside of the truck body. Attached [illegible] of the screw just inside of the body is a ratchet [illegible] a pawl is dropped to prevent screw from [illegible] because of vibration, and loosening the belt [illegible] working.

Next to the generator, and mounted on the same wooden [illegible] are two wooden spools, acting independently of each [illegible] carrying 250 ft. of 4/0 copper wire. These spools [illegible] with an axle shaft of 1¼-in. pipe. The inner end of the wire passes through the drum and into the shaft [illegible] cut in the side, coming out at the end which [illegible] over the side of the truck. Here connection is made with the lead wire from the generator by means of a wing-[illegible].

A [illegible] on the end of the axle shaft into which a [illegible] is screwed so that the wire may be readily reeled [illegible].

[illegible] rear of the truck, and on the frame which carries the generator and reels, is the instrument board. On this board is mounted the main switch, a rheostat, an ammeter, a voltmeter, and a small switch which controls the lighting circuit. Five lamps have been installed on the truck for [illegible] work.

Electric Thawing Outfit of Dedham Water Co.

Some experimental work was necessary before the officials were satisfied that they had an outfit that was practical. One of the first obstacles was to develop the maximum power of the engine and prevent excessive heat and boiling of the water in the radiator. At first an auxillary tank of water was attached to the radiator. While this stopped the boiling to a great extent, the engine did not furnish all the power and speed desired and which it was thought capable of developing.

The ignition was then investigated, and it was found that the magneto was operating with a fixed spark, not far enough advanced to give the maximum speed. The magneto was [illegible] and six dry cell batteries with a two-cylinder timer [illegible] control lever, substituted. This change gave the [illegible] speed and also allowed removal of the auxiliary water tank.

The [illegible] obtained was to develop 230 amperes at [illegible] volts. This amount of current it is figured will be sufficient for thawing purposes.

Experiments were made with the full amount of wire [illegible] on the truck frame and with water resistance.

Much of the material used in the construction was discarded [illegible] can be found around any waterworks plant. The largest item of expense was the generator. This together with the switches, rheostat, ammeter and voltmeter, cost $1[illegible]. The expense of rewinding the armature was $[illegible]. Other material which had to be bought, including wire, amounted to approximately $235.

Control of Water Purification Plant Operations in Quebec.—A method of "continuous control" of water purification plans in the Province of Quebec has been used by the Provincial Board of Health for several months. The method consists in the examination, for the presence of B. Coli, of daily water samples, sent by mail. By this means, any decrease in the efficiency of the plant may be quickly detected and remedied before harm is done. Better results have been obtained from chlorination plants by this continuous control.

Causes of Leaks in Main Pipes at Springfield, Mass.—During 1919 there were 36 leaks in main pipes of the water system of Springfield, Mass., an average of 0.155 per mile of main pipe in use. The causes of these leaks, according to the last annual report of the Board of Water Commissioners, were as follows: 20 were at defective joints; one was a broken Smith sleeve, 5 were at hydrant connections, 4 were from cracked pipe, 1 was caused by the blowing out of an 8-in. plug, 1 bend pushed off, and 4 were of lesser degree of importance. In addition to the above, there was one at a joint in the 42-in. supply main from Provin mountain in gate chamber at the west side of the Connecticut River.

Industrial Notes

"Blawnox" is the new name conferred by the United States Senate upon the town of Hoboken, Pa., the home of Blaw-Knox Co. The Blaw-Knox Co. first established in Hoboken about 5 years ago, occupying a comparatively small shop, at the same time operating another plant at Wheatland, Pa. About two years ago the latter plant was removed and added to the Hoboken works. The magnitude of the works has since increased. About 1,000 persons are employed in the Blaw-Knox shops, most of them live in Old Hoboken. A petition signed by the people of the town asking the Senate to change the postoffice name to Blawnox has just been granted.

The Thew Shovel Co., an Ohio corporation, has acquired all the outstanding capital stock of the Thew Automatic Shovel Co. of Lorain, O., and the two companies have been consolidated. The Thew Shovel Co. has assumed all the assets and business of the Thew Automatic Shovel Co. together with the legal liabilities and obligations. The officers of the Thew Shovel Co. are, President, F. A. Smythe; vice-president, H. H. Harris; vice-president, A. B. Taylor; secretary, C. B. Smythe; treasurer, R. E. Miller; sales manager, H. E. Billington; general works manager, J. S. Small, and purchasing agent, H. B. Newton. The consolidation gives the Thew Shovel Co. net assets of $2,000,000, and it is planned to increase the productive capacity of the company 100 per cent during 1920. New buildings have been completed and others are under construction.

Personals

M. J. Archbold of Decatur, Ind., has been appointed manager of the municipal water, light and steam plant at Garrett, Ind.

W. M. Scott, civil engineer, has been appointed chief commissioner of the Greater Winnipeg Water District of Winnipeg, Man.

Harry Eaton, Wilkes-Barre, Pa., has been appointed engineer in charge of operations for the Wyoming Valley Water Supply Co.

Luther Fawcett, assistant county surveyor, has been appointed chief platting engineer for the city planning commission of Youngstown, O.

David M. Earle, heretofore assistant city engineer of Worcester, Mass., has been elected city engineer, succeeding Frederick H. McClure, resigned.

Walter E. Baumgardner, for the past two years city manager of Albion, Mich., has resigned to accept a similar position at Alpena, Mich., at $1,000 per year.

Edgar Parsons, civil engineer, has been elected city manager of Springfield, O., succeeding O. E. Carr, who resigned recently to accept a similar position at Dubuque, Ia.

Ralph G. Lingley, assistant street commissioner of Worcester, Mass., has been elected superintendent of sewers to fill the unexpired term of Mathew Gault, who died recently.

Benjamin H. Lampert, head of the Lampert Construction Co., Oshkosh, Wis., has been appointed superintendent of the municipal waterworks and consulting engineer for the city.

Frederic W. Erickson and Henry M. Taylor, consulting engineers, have opened offices at 383 Madison Ave., New York, for the practice of electrical, civil and mechanical engineering.

The Civil Service Commission of Ontario has announced the following recent appointments: Hydraulic engineers, reclamation service, interior: G. F. Richan, Winnipeg; G. F. Horsey, jun., Ottawa. Assistant hydraulic engineers: W. C. Warren, Ottawa; W. T. McFarlane, Ottawa; D. Whitaker, Ottawa; G. H. Wood, Ottawa; H. J. Cooper, Winnipeg; J. H. Byrne, Ottawa. Junior irrigation engineers: C. M. Moore, Calgary; J. H. E. Jaffray, Calgary.

Edward Bartow, chief of the state water survey division of Illinois for the past 15 years and professor of sanitary chemistry at the University of Illinois, has been appointed head of the University of Iowa's department of chemistry. He succeeds Prof. E. W. Rockwood, who has been head of the department since 1904, and who is relieved at his own request of his administrative duties, although retaining his full professorship in the department. Prof. Bartow is a graduate of Williams college and has the degree of doctor of philosophy from Gottingen. He taught chemistry at Williams college and the University of Kansas before going to Illinois, where he was first associated professor of sanitary engineering and later full professor. He has served as a member of various state and federal boards and commissions, including one which investigated the causes of coal mine explosions in Kansas and another which considered standards of water for interstate carriers. During the war Dr. Bartow served as major and later as lieutenant colonel in the sanitary corps.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor*   LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulation. Member Associated Business Papers, Inc.

Volume LIV.   CHICAGO, ILL., JULY 21, 1920.   Number 3.

What Is the Distinction Between "Scientific Management" and "Psychological Management?"

In our last Foreign Engineering Review issue, June 30, we reprinted an article by an English psychologist, C. S. Myers, who made the following statement:

> Scientific management has made a great contribution to the future improved organization of industry and commerce. But without the co-operation and guidance of men trained in the principles of psychology and physiology, the merely mechanical innovations advocated by the engineering or other technical expert are fraught with great danger, and are liable to lead to disastrous results. Scientific management needs to be supervised and controlled by psychological management.

When carefully analyzed this conclusion is absurd. Psychology is a science, hence "psychological management" must be scientific management. How did it happen, then, that an apparently intelligent writer made such a blunder? Two reasons may be given for his error: "First, lack of training in logic, and especially in the part of logic relating to definitions. Second, confounding a narrow system of management (that of F. W. Taylor) with the science of management in general.

After the expression "science of management" had been coined, Taylor siezed upon it as a name for what had been previously known as "the Taylor system of shop management." Taylor reprinted his original paper on Shop Management (1903), with no fundamental changes, in book form under the title of "Scientific Management" (1911), three years after the first code of laws of management had been published the terms "science of management" and "management engineering" had been coined. But such publicity has been given to Taylor's "Scientific Management" that it is not surprising that many people regard "Taylor's system" and "scientific management" as being synonymous. "Taylor's system" is unquestionably scientific, but it is not, and never was, coextensive with the science of management. It was no more a science of management than Faraday's discoveries were a science of electricity. In fact, Taylor originally called his system of management an "invention," a new combination of four old elements. An invention may be scientific, but a science it can never be.

Taylor failed to see that by generalizing the four methods that comprised his "system," and by similarly generalizing all other successful methods of management, a code of laws of management could be produced. He failed also to see that such a code of laws when accompanied by proof of their truth and data for their application would constitute a science of management. Naturally he did not avail himself of the principles of psychology, for he was not trying to produce a science of management, but was merely expounding the Taylor system of management. Consequently when anyone confounds the "Taylor system" with the science of management, there results such absurd conclusions as the one above quoted from Mr. Myers' article.

Taylor himself was not wholly blameless for this confusion, for he not only accepted without protest the title of "father of the science of management," but he adopted without acknowledgment the term "science of management" as if it were his own creation. His disciples have, however, gone even farther, boldly claiming as his the conception of and the name for this new science. (See the Bulletin of the Taylor Society, October, 1919, page 12.) Were it not for this disregard of the facts there would be today no such revulsion of feeling toward scientific management as is voiced by Mr. Meyers thus:

> Of recent years efforts have been made to introduce from the United States into this country a system of industrial organization known as "Scientific Management." These efforts have not been successful. The British workman is absolutely opposed to Scientific Management, and the cause of this attitude is not hard to find. It has arisen partly because a system which has met with some temporary success in one country has been introduced without modifications into another, where the conditions of labor are obviously different. But a more fundamental cause of failure is that Scientific Management as originally advocated cannot be expected to be generally or permanently successful in any civilized land.

What Mr. Myers is really attacking is not scientific management but the Taylor system of management. In fact his very remedies for industrial ills are based on psychology, and are, therefore, scientific. The British workman opposes piece-rate systems of payment, whether the Taylor sort or any other. But the workman does not deny that the output of workers increases when they are paid in proportion thereto. In other words, he does not deny the truth of this fundamental law of management. What he really fears is that in the long run, he will not be permitted to secure his share of his increased output. Here it is that the psychologist may perhaps step in to advantage, and show managers how to dispel the fears that lead workmen to oppose increased output. But if psychologists are able to bring about this change of feeling, and if they can announce methods whereby others may accomplish the same results, then those very methods will become part of the science of management.

Taylor's attitude toward those who proposed any changes in his "system" was one of intense antagonism. He inveighed against all methods of payment other than the "Taylor differential piece-rate method." His was not the attitude of one whose aim was the development of a new science, but rather of one who was defending a new invention against all rival inventions. So it came about that during his lifetime his "system" was violently opposed, largely because of his own violence in denouncing other managerial systems, and now after his death we often see scientific management derided because it is confused with the narrow "system" that bears Taylor's name.

Chicago's Excessive Appropriations for Public Utility Appraisals

The Chicago city administration has been fighting every attempt of any utility company to secure an increase in rates charged for service. Many another municipal administration has been doing the same thing, but never, so far as we know, has so much money been wastefully expended for such a purpose as in Chicago.

The Mayor has asked an appropriation of $260,000 with which to pay real estate "experts" for appraising the real estate of the elevated railway. The city council has pared this down to $85,000, which is almost six times what it cost to have the same appraisal work done in 1916 by the Parsons-Arnold-Ridgway traction commission. But bad as this is, further information shows it to be even worse. This same real estate has already been recently appraised not only by the commission just named, but by the Illinois Public Service Commission. Yet the political leaders in Chicago would have the public believe that a quarter of million dollars should be spent by the city for the same purpose! Inexcusable as the proposed $85,000 expenditure for real estate appraisal of the "L" lines is, the proposed expenditure for engineering and accounting work is almost, if not quite, as reprehensible. The appropriation for this valuation work is as follows:

Engineers, accountants, etc.	$180,000
Real estate experts	85,000
Attorney's fees	12,500
Court reporting, etc.	4,300
Total	$281,800

The Mayor has asked for half a million dollars for this appraisal work, and a generous council has given him $281,800, or enough to make six such appraisals and have some to spare, if the work were done properly and with no thought of rewarding political hangers on. The editor can speak with authority on this matter, for he has himself been in charge of the appraisal of almost a billion dollars worth of public utility plants, inclusive of his appraisal of the railways in the state of Washington when he was chief engineer of the Washington Railroad Commission. Based on this personal experience, supplemented by knowledge of what such appraisals usually cost, the editor does not hesitate to denounce the proposed expenditures by the city of Chicago for the appraisal of the elevated and surface lines as being an outrage upon the taxpayers.

The total municipal appropriation for the appraisal of the surface lines is as follows:

Engineers, accountants, etc.	$190,235
Real estate, etc.	113,567
Attorney's fees	57,500
Total	$361,302

Adding this $361,302 to the $281,800 above given we have a total of $643,102 appropriated for what? Mainly for duplicating work already done. The traction companies have themselves made a complete inventory of their property, which the engineers of the Illinois Public Service Commission have checked. Engineers rarely differ as to the quantities involved in any appraisal, and when they do differ there is never a difference of any consequence. Their main points of difference relate to the unit prices and to the depreciated condition of the plant. Hence a city is rarely if ever justified in spending any money to make an independent inventory of the quantities. For a relatively insignificant cost the accuracy of any inventory can be checked by the city's engineers. It is in the making of a complete inventory of quantities that nearly all the money is expended in making an appraisal of a public utility plant. The pricing out of the quantities is relatively inexpensive. But the city of Chicago has appropriated enough money to make several complete inventories, as well as to price them out, when all that needs be spent is for checking the existing inventory and pricing it out. In the hands of a competent and honest appraiser $50,000 would suffice to make the proposed appraisal of the traction lines, instead of the $573,000 (exclusive of $70,000 attorney's fees) which it is proposed to spend.

The municipal appropriation for telephone litigation in Chicago is scarcely less outrageous than that for the traction lines. It is as follows:

Engineers, accountants, etc.	$ 35,000
Real estate, etc.	36,742
Attorney's fees	30,000
Total	$101,742

It will be noted that the three appropriations above given contain a total of $100,000 for attorney's fees. We shall not attempt to pass judgment on this item. The attorney in charge of this litigation receives $150 a day. The appropriation will suffice to keep two such high-priced attorneys busy for a year.

The Western Society of Engineers would perform a great public service were it to investigate the proposed use of city funds in such a wasteful manner, particularly as a large part of this waste will be at the hands of engineers. These engineers may be entirely innocent of intentional waste, for they may be directed by the Mayor or the City Attorney to make an elaborate appraisal for which there is not the slightest need. It will be injurious to the whole engineering profession if engineers play any part, however innocently, in this particular drama of municipal extravagance.

Book Review

Earthwork and the Cost (Third Edition), by Halbert P. Gillette; McGraw-Hill Book Co., 239 West 39th St., New York City; 4¾x7 ins., 1,350 pages, illustrated, flexible binding, $6.

This new edition of Earthwork contains six times as much matter as the last edition contained, and is by all odds the most comprehensive book yet published on earthwork. The titles of the 22 chapters are as follows: (1) Properties of Earth, (2) Measurement, Classification and Cost Estimating, (3) Boring and Sounding, (4) Clearing and Grubbing, (5) Loosening and Shoveling Earth, (6) Spreading, Trimming and Rolling Earth, (7) Hauling in Barrows, Carts, Wagons and Trucks, (8) Methods and Costs with Elevating Graders and Wagon Loaders, (9) Methods and Costs with Scrapers and Graders, (10) Methods and Costs with Cars, (11) Methods and Costs with Steam and Electric Shovels, (12) Methods and Costs with Grab Buckets and Dump Buckets, (13) Methods and Costs with Cableways and Conveyors, (14) Methods and Costs with Dragline Scrapers, (15) Methods and Costs of Dredging, (16) Methods and Costs of Trenching, (17) Ditches and Canals, (18) Hydraulic Excavation and Sluicing, (19) Road and Railroad Embankments, (20) Design and Construction of Earth Dams, (21) Dikes and Levees, (22) Slips and Slides.

Dividends on Unearned Increments in Value

To the Editor In reference to your article "Are Railway and Public Utility Companies Entitled to Dividends Upon Unearned Increments' in Value " in your issue of June 16

It is generally overlooked that there are two elements in income of "value" or more correctly increase of price. Price may change due, (a) to a change in the value of money and (b) to speculative or "community made" values. In the first case the worth remains constant and in the second case it increases.

Thus, as you will express it, if a plant is priced $50,000 when the dollars equals 100 ct. it is or should be priced $100,000 when the dollar equals only 50 ct. in purchasing power. On this basis dividends will be doubled but their value (purchasing power) will remain unchanged. If this is not allowed dividends would in effect actually be cut in two. There is no doubt at all that in equity companies are entitled to this readjustment (not increase).

As to community made (speculative) values there is equally no doubt that public utilities are not entitled to them. That is really the thing that courts and commissions have in mind when they shy off. If this distinction were made clear to them, they could not help allowing the former or refusing the latter. "Unearned increments of value" are the latter only. The former implies no change of value at all.

O. B. GOLDMAN

Professor of Heat Engineering, Oregon State Agricultural College

Corvallis, Ore

Cost of Levee Construction in Louisiana

To the Editor The article, "Cost of Levee Construction in Louisiana" on page 673 of the June 16 issue of "Engineering and Contracting" loses sight of the fact that convict labor is utilized in the levee work.

According to the article, the cost of moving earth by "power-driven machinery, scrapers drawn by mules, and men with wheelbarrows is 21.50, 46.00 and 31.05 ct. per cubic yard respectively. This would indicate that the wheelbarrow method was cheaper than the scraper method, which is erroneous.

If one man handled 5 cu. yd. a day in a wheel-barrow (considerably more than a fair average day's work) at 31.05 ct., he would earn $1.5525 per day. The commonest of labor cannot be obtained at such a low figure. Convict labor is largely used, which means subsistence and a slight fee to the state for their services, totaling about $1.50 per day which approximately checks the figure of $1.55 previously obtained.

RALPH EARL.

Assistant Director, Sewerage and Water Board of New Orleans

New Orleans, La

Production in 1919 and 1920

To the Editor: I sent you recently a communication which you printed in your issue of June 16, p. 67[illegible], with the heading: "Will Production in 1920 Equal that of 1919."

Some figures in your July 7 issue gave means of making more precise and up-to-date the answer to that question, a definite answer to which was attempted in my former letter.

Following the same procedure outlined in that letter, using the data from your July 7 issue, this result is obtained. The average of bank clearings for United States for the 7 weeks from May 10 to June 26 this year, was 8,532 million per week; for the corresponding weeks of 1919 the average was 7,842 million, an average increase of 690 million or 8.8 per cent. Commodity prices (average of all commodities), according to your article, in May this year were 31.4 per cent higher than in May last year. Then the production of commodities or volume of production would be clearings divided by price, or for last year 100 divided by 100 equal to 100 and for this year 108.8 divided by 131.4 equal to 82.6, in May or the falling off in production is nearly 18 per cent.

Such a fact should be of some use to a man having large public expenditure in his control or large expenditure of any kind in the matter of forming a policy to be pursued. To a single individual its importance in regulating his course to pursue would be less, in fact probably practically very small. If we had scientific management of large affairs such as those of the nation and the states and of large corporations such quantitative considerations would be of value and importance in influencing public officials to take the right course for the good of the whole people. But while public officials pursue the course their own "interest" (as they think) dictates and while they follow not merely their own "interest" but their immediate interest only, disregarding even their interest of the relatively close future, to point out such quantitative deductions from statistics will not, it may be, produce much effect. Still it is interesting and it may lead some people to think and that must be beneficial since discussion of public questions must, on the whole lead to better solutions of such questions.

Your work on the question of the factors controlling average prices of all commodities is deserving of the very highest praise and will be valuable for all time to come. You deserve the thanks of all economists and students of public affairs for your thoroughgoing investigation of that question and your daring thinking and clear-cut forceful writing on the subject. Your formula is very helpful and leads to clearer thinking in the matter. It deserves to be studied by all engineers and especially by all who have large sums of money to spend. Though I will say that I think there is a hiatus in the conclusion, the final conclusion, you reach from the application of the truth drawn from the formula to present conditions, i. e., as the line of policy to follow.

JOHN WILKES, Civil Engineer

Nashville, Tenn.

The Tendency Toward Greater Use of Welded Joints for Tracks in Streets*

There is no longer any doubt that the welded joint of some form is the one toward which modern construction practice, for tracks in paved streets, is tending. Current practice includes the use of four principal forms of welds which are the cast weld, electric bar weld, the unit weld and electric arc weld. The cast weld is included in the list as a weld by courtesy, as it were, although it is quite well known that a real union of the cast iron and the rail steel is seldom obtained. The reasons for this tendency toward welded joints are not far to seek, as they are based upon the need for the elimination of continual pavement disturbance, the noise from battered loose joints, the untimely destruction and removal of rails and the simplification of the bonding problem.

In recent years remarkable results have been obtained with the first three types of welded joint above mentioned, and each of them has become standard on many systems. Since time in plenty is required to develop defects, we may expect several more years to elapse before the industry will settle down to any single type of weld as the prevailing one. Meanwhile, the arc-weld type, though a comparative newcomer in the field, is proving a rather formidable contender for the honors, and several important companies have practically standardized them after years of experiment with the older types. One reason for this is the cheapness of the arc weld as compared with the other types of weld. Another is the simplicity of application, although at least one of the older types has this particular advantage also.

The increasing use of the newer type of weld seems to call for careful consideration at the hands of the maintenance engineers because of the dearth of information concerning the action of the heat from the electric arc upon the rail steel. Opinions vary radically as to this, and we feel certain that the industry will benefit greatly if the whole subject of welded joints could be made the object of a careful investigation at the hands of an unbiased authority such as the United States Bureau of Standards. Such an investigation would be somewhat costly, but the industry could well afford partly or wholly to finance it.

---

*Editorial in the Electric Railway Journal.

The Law of Managerial Reliance upon Specialists

By HALBERT P. GILLETTE, Editor

When testifying before a congressional committee the head of the U. S. Steel Corporation, E. H. Gary, was asked whether his personal decisions did not control the destinies of scores of thousands of men. He replied in the negative, stating that it is his policy to follow the decisions of his subordinates in all matters that are delegated to them. [illegible] this reply was as startling as it was unexpected, for the average legislator, whether in the federal congress or in a city council, is accustomed to ignore the advice of subordinate experts and specialists, preferring to rely upon his own judgment even in matters that are highly technical. For example, John Ericson, during his long term of office as City Engineer of Chicago, periodically urged the city council to authorize universal metering of the water supply. His advice was always ignored, because the successive councils regarded themselves as better judges of what was economic or at least expedient. Themselves quite ignorant of the experience of other cities that had adopted universal metering, the councilmen would not follow the advice of a city engineer who had made an exhaustive study of the economics of universal metering.

Contrasting Judge Gary's policy with that of the typical politician, it is not difficult to understand why the one is the successful head of one of the greatest industrial organizations, whereas the other is one of a class that has brought the words politician and politics into general disrepute. Judge Gary selects competent specialists to solve the economic problems that daily arise. He even has specialists whose specialty is selecting specialists (an art in which he himself is no mean expert), but having once delegated an investigation to a competent man or group of men, thereafter his main concern is in executing promptly what they advise.

By a similar plan the late E. H. Harriman was able to convert the Southern Pacific Ry. into one of the most profitable transportation systems in America. Harriman was never as outspoken in his praise of his specialists as was Andrew Carnegie, who attributed almost his entire success to them. But it is well known among railway engineers that Harriman executed, almost to the letter, every important plan submitted to him by his engineers for increasing profits by reducing operating expenses, even though millions of dollars had to be invested to effect the result.

Contrast the celerity and energy with which a Harriman executes a plan submitted to him by his engineers with the slowness and apathy that political executives and legislators act upon similar expert advice. The making of comparisons of this sort should itself bring out the fact that it is a principle or law of management to follow the advice of specialists to whom have been assigned the solution of specific problems. Yet I do not recall having seen this principle formulated in any article or book on the science of management. Should it be replied that it needs no formal enunciation because it is self-evident, it may be suggested that Euclid did not think it unnecessary to omit axioms from geometry but, on the contrary, founded the entire deductive structure of his geometry upon self-evident truth. Furthermore, many truths become "self-evident" only when formally announced as truths. Prior to such formal presentation, they frequently escape attention, and therefore receive little or no heed.

The beginner at whist is prone to think that he has almost mastered the game after playing a few hands. What could be simpler than the rules of the game? Almost all there is to it is the rule that the highest card takes the trick. But after a while the learner finds that it is no small task to remember even the few cards that have been played, to say nothing of the rest, and that it is essential to develop a card memory if one is to win against skilled adversaries. Coincidently it is ascertained that there are codes of "signals" that partners use, and that without knowledge of such a code a player is badly handicapped. Eventually the learner comes to see that he will always be a learner at whist, and that the seemingly simple game is tremendously complex.

For whist substitute any branch of knowledge, or almost any twig of any branch, and it will still be true that study of it must never cease if one is to master it. Of a German biologist who had spent his entire professional life studying the anatomy of the louse, it is narrated that upon his deathbed he said: "My only regret is that I did not confine all my investigations to the respiratory organs of that insect." An entire louse was too big a world for one man to conquer. Although told in jest, this anecdote really shows the conclusion to which every thorough specialist comes, namely, that, narrow though his field of inquiry, its depth is immeasurable. In similar vein, but wholly in earnest, an agricultural expert recently said that there are enough unsolved chemical and biological problems in a cubic foot of loam to keep a host of scientists busy for generations.

The density of a man's ignorance about any subject is measurable by the degree of respect that he shows for the subject. Does he speak of it very slightingly? Then correspondingly slight is his knowledge of it. Similarly when any man shows scant regard for the opinions of specialists, that man is probably a specialist in nothing and ignorant of everything.

A specialist is one who has devoted a great deal of time to making observations of, and drawing inferences from, some relatively limited class of things. Thus an expert trout fisher is a specialist quite as truly as is an expert designer of hydraulic machinery. A specialist is not only more apt to see the significance of a fact in his specialty than is a non-specialist, but is less apt to overlook any significant fact. Since all reasoning is based on an understanding of the relationships of things, it follows that a specialist is more apt to reason correctly in his field than is a non-specialist, even when the very same facts lie before them both. It is not enough that the data be present to the view; they must be seen and their significance must be grasped to be of any use in drawing conclusions. A very acute intellect may fail completely in reasoning about a relatively simple problem because of lack of practice in observing and classifying the data that pertain to that class of problem. This accounts largely for the frequent failures of very intelligent men who attempt to direct others who are less intellectual but more expert. On the other hand, the most successful executive is commonly a man who, while not accepting expert advice without question, makes it his practice to follow the advice of specialists. If he is in doubt, he frequently calls in other specialists to pass upon the questionable advice of a specialist. This he does rather than attempt to solve the problem himself.

The foregoing may be summed up in this law of management: To secure the greatest efficiency, every business plan should be based on the advice of specialists to whom it has been submitted as a definite problem to be scientifically solved.

Allotments to Railroads from $300,000,000 Fund of Transportation Act.—Detailed recommendations for the distribution of the sum set aside out of the $300,000,000 revolving fund provided by the Transportation Act for the purchase of new equipment and for additions and betterments, were made to the Interstate Commerce Commission July 1 by Thomas Dewitt Cuyler, chairman of the Association of Railway Executives. The report proposes the distribution among the roads of $86,000,000 to be used in rebuilding and repairing 12,616 cars and locomotives and in the purchase of 898 new locomotives and 45,000 freight cars and $35,000,000 for additions and betterments to promote the movement of cars.

Pre-War and Present Prices of Railway Equipment.—Some interesting comparisons are found in a statement submitted to the Interstate Commerce Commission on behalf of the western railways in the pending rate advance case, which have been prepared by Samuel M. Felton, president of the Chicago Great Western Ry. Co. Mr. Felton shows that consolidation engines, bought in 1909 for $15,500, now cost $38,000 each; 72-ft. steel coaches could be had in 1910 for $15,236, and in March of this year bids for similar coaches called for an expenditure of $38,000 each; open hearth rail, early this year, was $47 per ton, and before the war it was purchased for $30; first-class white oak ties sold for 56 ct. each in 1915; in 1916 they had been advanced to 66 ct., and now they are quoted at $1.75 each.

Improved Design for Dredge Pump Sump for Hydraulic Fill Construction

A new sump design for the dredge pumps engaged in the construction of the hydraulic fill dams of the Miami Conservancy District of Dayton, O., has recently been placed in service at the Englewood Dam. The new sump cuts losses in the velocity head, and reduces shutdowns due to plugs. The arrangement is described by Mr. H. S. R. McCurdy, Division Engineer of the District, in the June Miami Conservancy Bulletin, from which the matter following is taken.

The improved layout can be best understood after a brief description of sump No. 1. This was the first of the Conservancy dredge pump installations. In working out its design an attempt was made to incorporate in the layout the best features of existing plants elsewhere. While the general assembly of the plant presented some new features, the various factors in its make-up were in more or less common use. It is shown in Fig. 1.

It has been common practice to set the dredge pump some distance above the level of the water in the sump and to use for priming purposes some form of device which would exhaust the air in the pump chamber, automatically filling it by drawing water through the suction pipe. In sump No. 1 this practice was followed.

It was recognized that bends in either suction or discharge pipe were objectionable, both on account of the increased friction induced by causing the material being pumped to change direction and also owing to the increased wear on the pipes at the bends. To reduce these objections, the suction pipe was fitted from pump to sump with an angle of 45°, rather than with the customary 90° elbow. The intake end was cut square; no attempt was made to so shape it as to facilitate the entrance of the material. The discharge pipe left the sump horizontally and contained a 25° elbow at the point where it started up the slope of the dam.

The sump consisted of a concrete well, 8 ft. square and 10 ft. deep, with a flat bottom. An attempt was made to assist the material in flowing to the suction pipe by building wooden sides in the bottom of the well sloping toward the end of the pipe, roughly in the form of an inverted pyramid.

All stones larger than 6 or 7 in. in diameter are liable to lodge in the pump runner, hence must be screened out before the material enters the sump. The first plan for doing this was to pass the material in its course from the hog box to the sump over grizzlies or screens made of steel bars set in 7-in. squares. The services of several men were required to keep the screens from clogging and to assist the oversize rock over the screens and into the bottom dump buckets set at their lower edge.

The installation of sump No. 1 did all that could have been expected of it. It probably did at least as much work and as good work as dredge pumps in general had been in the habit of doing. But a close study of its operation, with a particular view to power consumption, output and all features entering into the rate of progress and cost of work revealed various possibilities for improvement.

In the first place the sump, or intake, was not well adapted for passing the material to the suction pipe of the pump. The gravel, sand and clay fell into an inert mass at the bottom of the well and had to be sucked up by the water entering the suction. The materials had a habit of piling up until the mass became so great that a large portion of it would slide down and bury the end of the suction, throwing a sudden throatful of "pudding" into the pump, overloading it, and making a plug in the pipe lines imminent.

Then again the suction was not efficient. The pumps in sump No. 1 had suction lengths of 18 ft. and the center of the suction as it entered the pump was 7 ft. above the water level in the sump. The pump while operating, showed 16 in. of vacuum, equivalent to 18 ft. of head. The loss of head in the suction pipe was, therefore, about 11 ft. This was due in part to velocity head, and in part to the friction in the pipe, due to its length and curvature and to the shape of its intake end. The net result of this type of sump well and of suction pipe was that unnecessary power was used, progress was limited and plugs in the pipe line were not infrequent. The latter were a particular annoyance, necessitating, as they did, an entire shutdown of the hydraulic fill operations while the pipe line was disconnected and cleaned, an operation frequently involving several hours.

Another objection to the first installation was the necessity of priming the pump before starting again, after every shut down. While ordinarily this was not a difficult operation, occasionally sand would collect in the injector which would have to be cleaned out. In the aggregate delays from priming amounted to a considerable loss of time.

As the embankment of the dam reached higher elevation and the length of discharge pipe materially increased the additional pressures required at the dredge pumps to move the material became strikingly apparent. These high pressures were found to be due, not only to the increased head, but to the coarseness and gritty character of the material from the borrow pits, which while rendering it excellent from the viewpoint of building a safe dam, gave a very high friction factor and greatly increased the resistance to pumping through long pipe lines. It became apparent, therefore, that it would be expedient to construct additional plants located at higher elevations and closer to the particular portion of the dam each would be called upon to build. With the decision to construct additional pumping installations came the opportunity to incorporate in them such improvements as had suggested themselves in studying the behavior of sump No. 1. Sumps Nos. 2 and 3 have now been constructed and operated and, as the latter is the latest model, this description will be confined to that layout. It is shown in Fig. 2.

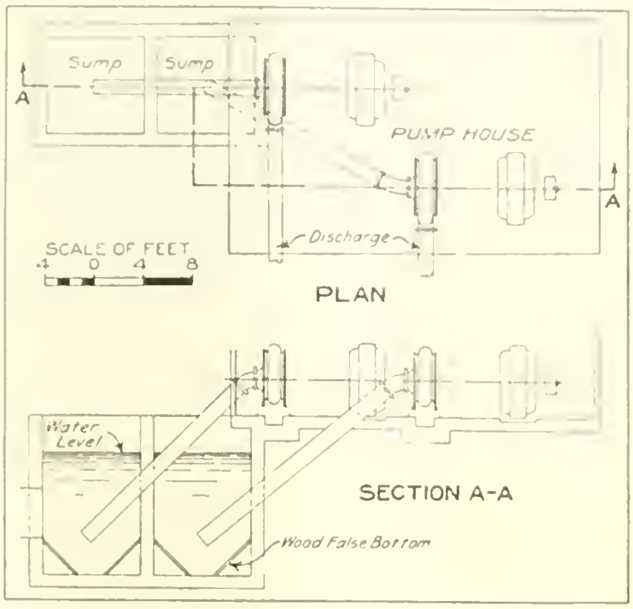


Fig. 1—First Sump Layout Englewood Dam.

The first radical change, however, came during the operation of sump No. 1 and consisted of abandoning the use of flat, sloping screens to eliminate the oversize rock and substituting for them cylindrical revolving screens. These screens are 12 ft. long, 4 ft. in diameter, are pierced with 7-in. circular holes and set to a pitch of ½ in. to the foot. They are revolved at a rate of 7½ R. P. M. by 7½ HP. electric motors. The material enters from the hog box at the upper end of the grizzly, the acceptable sizes fall directly into the sump and the over-size passes to the lower end, from which it drops into a standard 12-yd. dump car to be hauled away. To reach out over the car a 6-ft. extension, flaring to 5 ft. diameter, was put on the lower end of the grizzly.

The position of the dredge pumps was also changed in the later installations. In the original layout the pumps were set 7 ft. above the water level in the sump and had suctions 18 ft. long. In the new layout the pump was set 8 ft. below water level. The result is that the pump is always primed ready for operation. The pump suction pipe is straight and horizontal, 5 ft., 6 in. long. As the sump end the entrance to it is given a bellmouth shape to eliminate contraction of the entering jet. The supply pipe bringing the return water from the core-pool (the circulation in the pumping layout being a closed system, pump to pool and back again, is in a direct line with the pump suction. Thus the flow is straight from the return supply into the pump suction. Between the two is a short open topped conduit in line with both, into which the material from the hog box is dropped as detailed in the next paragraph. Loss of energy at the pump suction is by these means materially reduced, tests showing a loss of head of about 3 ft. as against 11 ft. in the old sump, a saving of 8 ft. Stated otherwise, and applied to our particular problem here, this means that the number of cubic yards of mixture of earth materials and water remaining to be pumped will require to be pumped through 8 ft. less height.

Another modification of the original plant, in sump No. 2, was in the design of the sump. In general, the sump is in the shape of an inverted pyramid, collecting the material as it drops from the revolving screen and concentrating it at the bottom. The bottom of the sump is fashioned into the shape of a horizontal circular conduit, 21 in. in diameter, open at the top. One end of this conduit receives the water from the supply pipe and the other end discharges into the steel [illegible] leading to the suction of the dredge pump. It is in its passage through this conduit that the water picks up its load of earth materials. The effect is of "shooting" sand, gravel and clay into a swiftly-moving stream of water. The advantage of this method over that originally in use is at once apparent. It will be remembered that in sump No. 1 the earth materials came to rest in the bottom of the sump and that the suction from the pump was called upon to create sufficient velocity from still water to move the material up into the pipe. And that material had to enter a re-entrant pipe end, with all its attendant contraction losses of the jet. In the new type of sump, however, the supply water enters from the return pipe with a velocity of 10 to 12 ft. per second. This velocity is largely conserved in the conduit forming the bottom of the sump, thereby giving the pump just that much of a boost.

In the old layout the discharge pipe left the pump horizontally, necessitating a bend up the slope of the dam. In the new design the pump was set at an angle of 27° with the horizontal, enabling the discharge pipe to be laid without bends. In this arrangement of suction and discharge the only deviation from a straight line occurring in the course of the pumped material from the sump up to the side of the dam takes place in the pump itself, incidental to the centrifugal pumping operation, consequently frictional resistance and wear are reduced to a minimum.

In the operation of a dredge pump discharging through long pipe lines it is of the utmost importance that the pump operator be continually informed as to the conditions of flow in the suction and discharge, with particular reference to the load of suspended materials being carried. Standard pressure and vacuum gages can be relied upon to a certain extent, coupled with an ammeter for electrical consumption, to indicate conditions. The vacuum gage will tell when the suction is becoming clogged. The pressure gage gives warning of heavy loads in the discharge line. But these indicators alone were not sufficient to prevent plugs in the pipe line, as proved time and again by bitter experience. To solve this problem the indicating device described in the caption to Fig. 3 was tried, and proved to be a distinct advance over anything heretofore used. Its operation was very satisfactory, but it involved long electrical circuits running to the ends of the pipe lines, and required removal and resetting for each new length of pipe added. Moreover, it had very little range, indicating only that the actual flow was equal to or greater than a particular discharge for which it was set. How much it exceeded this, or by how much it fell short could not be told at the pumps. At sump No. 2, however, a device has been put into service which meets the objections to the former indicator and, in addition, gives full information as to conditions at all working stages of flow. It indicates the water level in the sump, and thus the working conditions in the pump line, as follows:

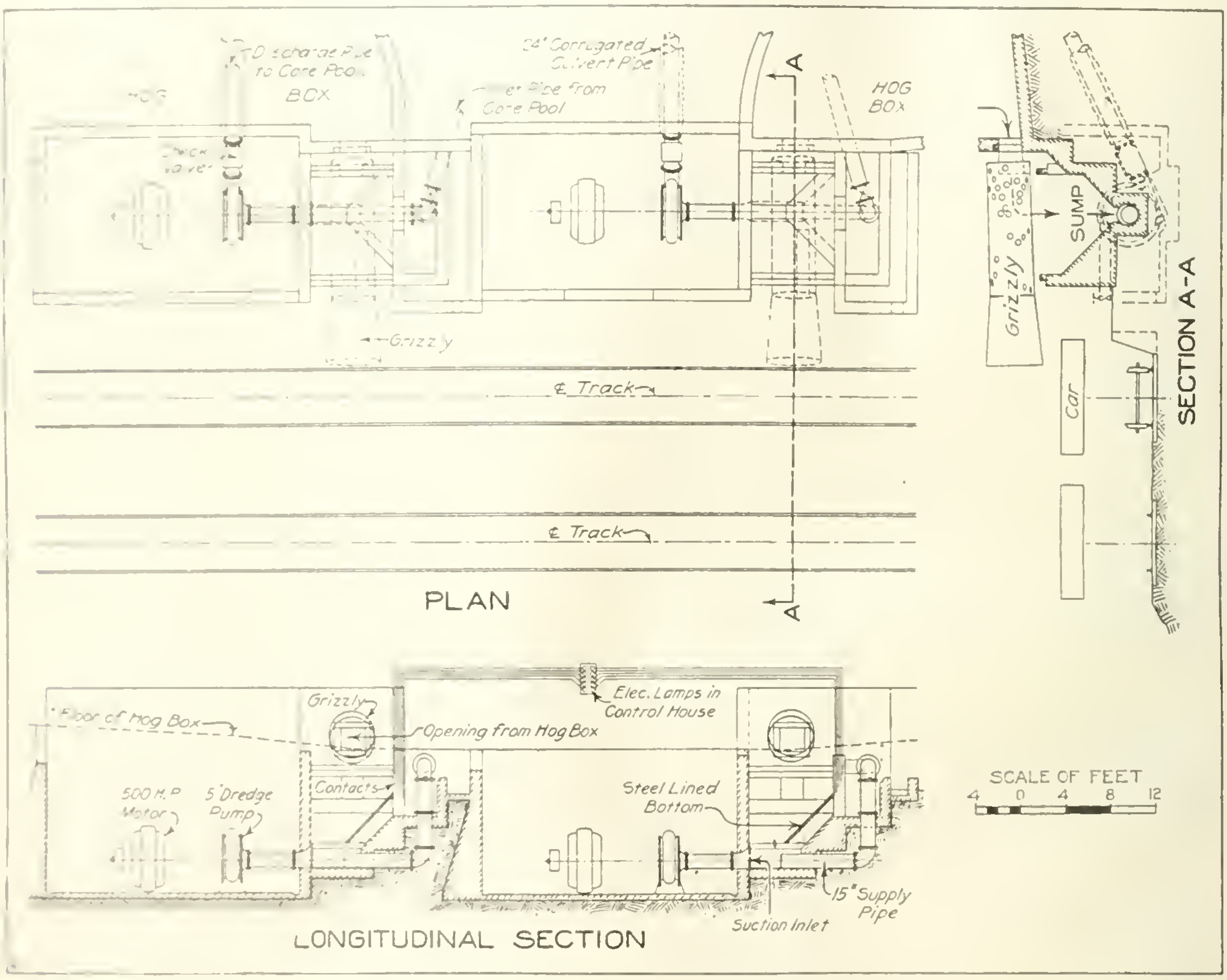


Fig. 2—Improved Dredge Pump Layout at Englewood Dam.

In the design of the plant the size of sump was made such that the water level responds readily to the demands of the pump. In operation, the valve in the return pipe from the core pool is opened to the point giving the proper flow as determined by trial. With an equal feed of solids from the hog box a speeding up of the pump causes a corresponding lowering of the water level in the sump. Conversely, decreasing the speed of the pump causes the level of the water in the sump to rise. With a constant speed of pump, increased feed of solids from the hog box causes the water in the sump to rise and decreased feed allows it to lower.

In actual practice the pump operator knows that if the water in the sump rises and the pressure gage shows increased pressure, at the same time that the ammeter shows decreased electrical current, his discharge line is being heavily loaded. If on the other hand, the water level in the sump lowers while the pressure gage shows decreased pressure and the ammeter indicates increased power consumption then he knows that the pump is handling less solid material. It is upon these phenomena that the warning device is based. It is necessary only to keep the pump man continually informed of the fluctuations of the water level in the sump and, with his gages, he can tell for a certainty what is taking place. The immediate warning comes from the water level in the sump; the gages simply explain the cause of the fluctuation.

It was found by trial that the fluctuations of the water level in the sump for ordinary working conditions were confined to the top 2 ft. When the sump was full, danger of a "plug" was impending; when the water level was 2 ft. down from the top the pump was not handling all the solids of which it was capable and it was up to the monitor men to sluice in more muck. (In practice the monitor men have instructions to flush the material into the sump as fast as they can unless warned off by the pumpman.) It was decided that indications of the water level should be shown to the pumpman at 6-in. intervals. To do this 0 gage solid copper wires, 5/16 in. in diameter, were suspended vertically, the bottom of one being at the level of the top of the sump, the bottom of another being 2 ft. below the top of the sump and three others ranged equally between. These wires were connected in circuit with incandescent bulbs mounted on the control board in the pump house one above another in the same relative positions as the terminals to which they were attached. To protect the eyes of the pump runner from the glare of the lamps the whole are placed in a box with a ground glass front, the top compartment being red to indicate the danger warning. The top circuit is also connected to a lamp on the giant to give the monitor man warning when the sump is full and feed should be slackened. The arrangement of this device is shown in Fig. 2.

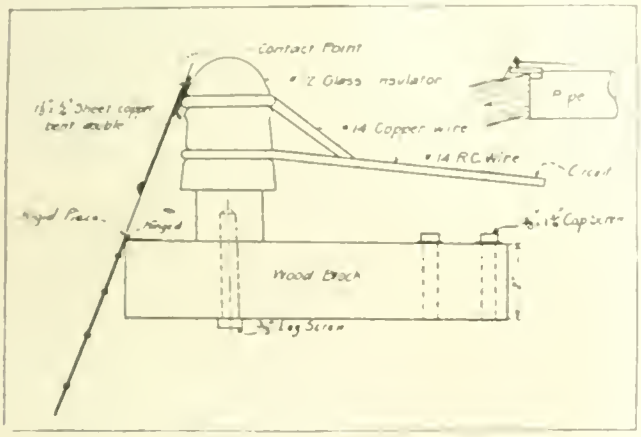


Fig. 3—Electrical Indicator for Dredge Pipe.

Diagramatic sketch of its attachment to the pipe, but not showing the clamps, is shown in the upper right-hand corner. The wood block above is screwed to an iron plate bent to the curve of the pipe and clamped to it. The working piece is the thin diagonal metal plate at the left, hinged to the top edge of the block. The lower part of this dips into the stream discharging from the pipe, as shown in the upper right-hand corner. The force of the stream keeps the upper part of the hinged plate in electrical contact with a metal point attached to the glass insulator. When the discharge slackens the lower part of the plate drops by its own weight and the contact is broken. An electric lamp in the pump house, which is in the electrical circuit then goes out, warning the pump man that the discharge has slackened to the danger point, indicating an incipient "plug" or stoppage of the dredge pipe by the suspended earth materials which it carries. The pump man then throws more power into his dredge pump motor breaking up the incipient plug and driving it on to the discharge outlet. This device worked well, but did not indicate how near the critical point of "plugging" had been reached. The new system described in the article corrects these shortcomings.

Fig. 4—Discharge End of Dredge Pipe Line, Showing Indicator.

As to the efficiency of the new installation of dredge pumps a few figures may be cited. Last year, from sump No. 1, the maximum output from one pump in a 10-hour shift was 259 12-yd. cars and from two pumps in the same time 483 cars. This season, 510 cars have been pumped with one pump in one shift to date, totaling 4,590 cu. yd. The rate of pumping was 58 cars, or 522 cu. yd. per hour, the actual running time being 8 hours, 48 minutes. The amount was limited only by what the draglines could excavate. How much the pumps can handle is not known, excepting that on May 17 one pump operated for 4 hours and 51 minutes at the rate of 64 cars per hour, when the supply of material gave out.

New Percentage of Income for Chapters of A. A. E. An order promulgated as of Aug. 1 by the board of directors of the American Association of Engineers and effective Sept. 1, provides for a new percentage of income allotted to the chapters of the association. The order was issued under authority of a resolution adopted at the recent convention providing that until the next convention the directors may promulgate working rules. Chapters with 600 or more members will receive 60 per cent of the entrance fees and dues received from members of the association residing in their respective territories. Such chapters will constitute one of four classes into which chapters are to be divided on the basis of membership and assumption of duties. This class of chapters will handle employment service, qualification committee work, and other local activities. They will maintain offices and paid employes. Chapters comprising the other three groups will receive a percentage of income carrying from 50 per cent to 35 per cent, depending upon the size and duties assumed. Chapters with from 350 to 600 members will get 50 per cent and will maintain offices with paid secretaries or managers. Chapters with from 100 to 350 members will get 40 per cent of income and will have paid stenographic help. Chapters with less than 100 members will receive 35 per cent of the income and will function on volunteer help only. This order will be effective unless protested by chapters of the association comprising 1,500 or more members. The same order carries with it an increase of dues for all members except student members to $15 per annum, an advance of $5 over present dues, effective Jan. 1, 1921. It is expected that at least 20 chapters of the association under these provisions will be able to engage full time paid secretaries. In addition to the five district secretaries, the association already has paid employes in several chapters.

Distribution Sheets of Contractor's Accounting System

The committee on Methods of the Associated General Contractors of America is now conducting an investigation with a view to the development of a standard cost accounting system for general contractors. As a step in this study the committee has published in the July [illegible] Bulletin of the association the distribution sheets of one of the members of the association whose accounting system has been found to be both practicable and accurate. These distribution sheets are as follows:

Distribution Sheet "A"

General Items
Item No. Class of Work.
1. [illegible] and assistant
2. Field [illegible]
3. Field [illegible]
4. Timekeepers, checkers and messengers.
5. Watchmen.
6. Telephone and telegraph.
7. Stationery.
8. [illegible]
9. Miscellaneous and petty cash expenses.
10. Permits and fees.
11. Fire and tornado insurance.
12. Liability insurance.
13. Fuel, lubricants and waste.
14. Temporary public utility service.
15. Temporary piping.
16. Temporary wiring.
17. Removing public utility obstructions.
18. Loading equipment at contractors' yard.
19. Transporting equipment to and from job.
20. Equipment rentals.
21. Equipment major repairs.
22. Equipment minor repairs.
23. Tool account—charges less credits.
24. Blacksmithing (no shoeing).
25. Special facilities.
26. Temporary structures.
27. Assignable railroad expenses.
28. Drayage of materials and supplies.
29. Traveling expenses.
30. Expediting shipments.
31. Weather hazard.
32. Bond.
33. Legal expenses.
34. Estimating and bidding expenses.
35. Safety work.
36. Medical and nursing aid.
37. Interest during construction.
38. Guarantees.
39. General office expenses.
40. General office draughtsmen.
41. General office salaries.
42. Patents and royalties.
43. Profit.
44. Property damages.
45. Flood protection.
46. Labor procurement.
47. Tests.
48. Special requirements.
49. [illegible] for delays.
50. Increases in freight costs.
51. Increases in labor costs.
52. Food provision and commissary.
53. Transportation of labor.
54. [illegible]

Distribution Sheet "B"

Item Preparation of Site
No. Class of work.
[illegible]
[illegible] and stumpage
[illegible] shovels
[illegible] grader
[illegible] and [illegible]
[illegible] labor
[illegible] support
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible] rail [illegible]
[illegible]
[illegible]
[illegible]
[illegible]
121. Temporary drainage pipe sewers to 7 feet
122. Permanent drainage
123. Drain-tiling sewer building to 7-foot depth.
124. Sewer building (no depth limit).
125. Wrecking structures.
126. Blasting with explosives.
127. Drivers on company teams.
128. Chauffeurs on company autos.
129. Hired teams.
130. Building raising.
131. Building moving.
132. Salvage operations.
133. Drill borings.
134. Steam heat mains.
135. Water mains.
136. Refrigerating mains.
137. Gas mains.
138. Electric conduits.
139. Oil mains.
140. Pneumatic tubes.
141. Irrigation pipe.

Distribution Sheet "C"

Item Excavation Work.
No. Class of work.
200. Earth excavation of cellars.
201. Earth excavation of basements to 12 feet.
202. Earth excavation of footings.
203. Shale and loose rock excavation.
204. Bracing banks.
205. Shoring adjoining structures.
206. Underpinning adjoining structures.
207. Pumping.
208. Temporary runways.
209. Open well excavations.
210. Buildings for caissons.
211. Pneumatic pressure work.
212. Moving excavating equipment.
212. Moving team camps.
213. Moving stablemen.
214. Powder men.
215. Hauling surplus.
216. Dumping expense.
217. Backfilling.
218. Handling quicksand.
219. Pile driving.
220. Handling frozen material.
221. Tunneling.
222. Railroad construction—cuts and fills.

Distribution Sheet "D"

Item Concrete and Materials
No. Class of work.
300. Concrete silos.
301. Concrete bridges.
302. Concrete reinforced buildings.
303. Concrete grain elevators.
304. Concrete dams.
305. Monolithic buildings.
306. Concrete foundations for buildings.
307. Concrete retaining walls.
308. Concrete culverts (under 20-foot span).
309. Sand and gravel digging.
310. Quarrying and crushing.
311. Stone crushing only.
312. Erection and removal of concrete plant.
313. Erection and removal of chutes and towers.
314. Erection and removal of material handling plant.
315. Unloading and hauling sand.
316. Unloading and hauling gravel macadam.
317. Unloading and hauling cement.
318. Unloading and hauling brick.
319. Unloading and hauling lime.
320. Unloading and hauling rubble-stone.
321. Unloading and hauling cut stone.
322. Unloading and hauling hollow stone.
323. Unloading and hauling cinders.
324. Unloading and hauling sawdust.
325.
326. Material storage and rehandling.
327. Concrete power mixing.
328. Distributing concrete.
329. Surfacing concrete.
330. Framing concrete forms.
331. Handling column forms.
332. Erecting wall forms.
333. Erecting beam forms.
334. Erecting slab forms.
335. Erecting stair forms.
336. Removing and cleaning forms.
337. Cinder fill.
338. Cinder concrete.
339. Heating concrete materials.
340. Heating protection for structure.
341. Precast concrete.
342. Concrete chimneys.
343. Fireproof floor constructions.
344. Concrete and metal lath walls.

Distribution Sheet "E."

Item Trowel Work.
No. Class of work.
400. Brick handling plant.
401. Laying brickwork.
402. Carrying and hoisting brick.
403. Enamel brickwork.
404. Face brickwork.
405. Mixing and handling mortar.
406. Terra cotta work.
407. Wall coping.
408. Pointing brickwork.
409. Hollow tile floors.
410. Hollow tile partitions.
411. Plaster block partitions.
412. Cut stone work.
413. Cutting stone in place.
414. Marble work.
415. Interior plastering.
416. Exterior stucco work.
417. Mantle setting.
418. Granitoid work.
419. Finishing floors.
420. Finishing bases.
421. Tile installation.
422. Mosaic work.
423. Applying floor hardening.
424. Asphalt laying.
425. Applying floor mastics.
426. Applying floor tiling.
427. Applying wall tiling.
428. Erecting rubble masonry.
429. Brick or tile chimneys.
430. Lining smoke stacks.
431. Light prisms.

Distribution Sheet "F."

Item Woodwork.
No. Class of work.
500. Woodworking plant.
501. Framing timbers.
502. Erecting timbers.
503. Setting grounds.
504. Setting frames.
505. Hanging windows and doors.
506. Interior trim.
507. Laying sub-flooring.
508. Laying top flooring.
509. Interior partitions.
510. Stair building.
511. Applying hardware.
512. Wood block flooring.
513. Setting fixtures.
514. Roof sheeting.
515. Roof crickets.
516. Platforms and canopies.
517. Bridgework.
518. Wood lathing.
519. Silo-erection.
520. Hot house erection.
521. Tank erection.
522. Scaffolding
523. Dumbwaiters
524. Weather strips.

725. Show cases.
726. Parquet floor laying.
727. Wood preserving, etc.
728. Jobbing work on building.

Distribution Sheet "G."

Item No. — Metal Work — Class of work.

Iron Structural Erection.

600. Less than two-story.
601. Where first two stories require members 6 tons or less.
602. Where first two stories require 6 to 15 tons.
603. Where first two stories require 15 to 20 tons.
604. Where first two stories require over 20 tons.
605. Steel erection plant.
606. Unloading structural steel.
607. Unloading reinforcing steel.
608. Hauling steel.
609. Erecting structural steelwork.
610. Riveting structural steelwork.
611. Bending reinforcing steel.
612. Placing reinforcing steel.
613. Placing inserts and spacers.
614. Placing anchor bolts.
615. Oxy-acetylene cutting and welding.
616. Metal tanks, exterior.
617. Metal tanks, interior.
618. Corrugated covering.
619. Lintels, sills and jambs.
620. Steel sheet piling.
621. Brass and bronze work.
622. Rolling doors.
623. Sliding doors.
624. Hinged doors.
625. Setting metal sash and frames.
626. Ornamental ironwork.
627. Stair railings and balconies.
628. Sheet metal flashing and conductors.
629. Sheet metal skylights.
630. Tinsmithing.
631. Sheet metal roofing.
632. Sheet metal fire doors.
633. Smokestacks.
634. Metal roofing.
635. Fire escapes.
636. Metal lockers and furniture.
637. Metal lathing.
638. Iron store fronts (alteration).
639. Erecting gasholders.
640. Prison vaults and cells.
641. Fire or burglar proof vaults.
642. Bridge building.
643. Lightning rod erection.
644. Metal shutters (exterior).
645. Metal ceilings.
646. Coppersmithing.
647. Wire work interior.

Distribution Sheet "H."

Item No. — Installation of Equipment. — Class of Work.

700. Elevator installation.
701. Electrical equipment.
702. Electric power plant.
703. Furnace installation.
704. Boiler installation.
705. Ventilating.
706. Steam piping.
707. Sprinkler.
708. Vacuum cleaners.
709. [illegible]
710. [illegible]
711. [illegible]
712. [illegible]
713. [illegible]
714. [illegible]
715. [illegible]
716. [illegible]
717. [illegible]
718. [illegible]
719. [illegible] installation.
720. [illegible]
721. [illegible]
722. Automatic stokers.
723. Leather belting.

Distribution Sheet "I."

Item No. — Finishing Work — Class of work.

800. Painting structural steelwork.
801. Painting buildings.
802. Glazing.
803. Paper roofing.
804. Slate and tile roofing.
805. Special roofing.
806. Paper hanging.
807. Decorating.
808. Upholstering.
809. Floor surfacing by electric machine.
810. Waterproofing.
811. Cleaning outside surface of building.
812. Plaster board.
813. Sign painting.
814. Cleaning premises.

Prolonging Life of Electric Railway Track

In view of the prevailing high prices for labor and material, electric railway companies have felt the urgent need of taking such means as appear feasible to prolong the life of existing tracks, rather than be forced to rebuild.

In a review of the modern methods of prolonging track life, Mr. E. A. Hoffman, Engineer of the Wilkes-Barre (Pa.) Railway, presented some interesting facts in a paper before the Pennsylvania Street Railway Association. The following is an abstract of the paper.

Consideration will be given first to a section of double track laid with heavy rail and substantial plain or continuous joints on a substructure apparently in good condition and surrounded with paving also in fair shape, but with the receiving rail slightly depressed, so that a slight pound has developed, which if allowed to continue will surely destroy the joint, the joint plates, however, are still tight. A few years ago the method of treating this condition would have been to grind off the high rail for a distance of a foot or more from the joint, thus forming a gentle incline to the low rail.

The modern treatment consists of applying steel with an arc welder to the head of the low rail, building it up slightly higher than the high rail for a foot or more from the joint and then grinding flush with the high rail at the joint and gradually slopping to the low rail. This avoids grinding away the rail head and, if the welding is skillfully done, requires much less grinding. Sections of track on our property treated in this manner four or five years ago are still in excellent condition, and the remarkable fact is that the receiving rail has not again become depressed. Apparently, the rails have "found" a bearing on the continuous joint plates. These tracks are from 12 to 15 years old and subjected to a 10-minute headway of heavy suburban cars running at comparatively high speed, yet this treatment, costing not more than $100 per mile is practically the only maintenance which has been required during that time.

In an extreme case where the rail ends are badly battered or broken out for several inches and the joint plates are hopelessly worn but the ties and the pavement between and outside the rails are in fair condition and good for several years it is certainly most desirable that the life of the track be prolonged until such time as the paving is renewed. In this case the most satisfactory plan is the application of one of the several types of joints especially adapted to arc welding, the low joints first being raised to as true a surface as possible by the use of metal or wood shims. After the joint plates are applied the battered or broken portions of the rail can be restored by the arc welder and the whole surface ground smooth. In this manner on our property, track which a few years ago would most certainly have been scrapped has been restored to a very fair operating condition with practically negligible maintenance during the past two years and is apparently good for three or four more years.

As another example, consider a section of open track which, having been in service for many years, is now difficult to maintain and noisy owing to the loose parts of the joints. The fishing surfaces of the plates and rails are worn so badly that the plates come in contact with the web of the rail, and the joints when tightened or even when newly bolted become loose again in a few weeks. Before the advent of the electric welder new joints would have been purchased and applied to remedy this condition. Now the joints are removed, built up and ground to a proper fit and replaced.

On a mile section of track where the joints had been restored in this manner nearly five years ago a recent inspection revealed not a single loose joint, although the only maintenance this track has received, aside from the renewals, was that given to it by the trackwalker. In this instance the rail ends were built up where battered and surfaced with a flexible shaft grinder. The rails have been in service nearly 20 years and under present traffic, consisting of a 10-minute headway, are apparently good for 20 more years. Another method of treating open track is to weld the joints, expansion joints being provided at intervals of about 500 ft.

In the past loose joints have been the bane of the maintenance man's life, but on roads which have consistently followed the above practices loose joints have ceased to be a serious problem. Defective joints have been the cause of the removal of many miles of track long before the remainder of the rail, ties or the paving were worn out. It has been accepted almost as an axiom among street railway engineers that the life of the joint was the life of the rail. The life of the joint today can be made nearly or quite equal to the life of the rail.

The Cost of Injured Men in Construction Operations

By F. A. DAVIDSON
Westinghouse, Church, Kerr & Co., New York

The advantages of accident prevention methods in construction work is set forth in an interesting article by F. A. Davidson of Westinghouse, Church, Kerr & Co., in a recent issue of the W. C. K. quarterly. In his article, which is printed below in abstract, he shows that by proper attention on the part of men and superintendents the accident rate has been reduced fully 50 per cent.

Accident Cost to the Victim. Before proceeding to definite figures it might be well to consider briefly just what is involved in the cost represented in injuries to men. First, there is the cost to the individual. Even if his injury is not severe enough to cause him to lose any working time he suffers more or less discomfort and pain. If the injury is severe, he loses working time and his income is cut off. After he has been incapacitated for a period of time which varies in different states but averages about 10 days he receives compensation. The amount he receives from this source, however, is far from equalling his regular income. As a result, in these days when living is so high and every penny counts, the man and his family have a hard time. If the man has been thrifty he sees his small savings dwindle away. Plans for improving his circumstances or for educating his children are forced into the discard. If, as often happens, the individual has been living up to the limit of his income and has nothing put aside for a rainy day, he and his family may suffer severely and even become objects of charity. Thus, to the injured man's physical pain is added worry and possibly the sufferings of poverty with its attendant ills.

Cost of Accidents to the Company. Next, there is the cost to the company. Whenever a man is incapacitated on the job, it is necessary to replace him by hiring another. Often and particularly when the job is located at a remote point or help is scarce it takes two or three days, or even longer to find and hire a suitable man. In the meantime a gang of men may be working short handed, that is to say, below maximum efficiency. Furthermore, even when a new man is hired it takes a certain length of time to break him in, instruct him in his duties and to fit him into his particular place in the organization. Thus, the replacing of an injured man means a certain if not a self-apparent loss to the company.

Again, it is a well known fact that whenever a serious accident occurs on a job there is a distinct lowering of the morale of the entire working force. The nerves of the injured man's fellow workers are shaken and if any time from a few hours to a day or two before there is a complete return to normal. During this period of reaction, there is a decided falling off in the amount of work performed, which all told results in a considerable loss. Moreover, every accident case has a direct bearing on the workmen's compensation insurance rates which the company must pay.

As the number of accident cases is large in the construction industry the rates are correspondingly high. Each individual case helps to swell the total and keep the rates high. On the other hand, if vigorous and successful efforts are made to reduce the number of accidents the total is consequently reduced and the insurance rates will in time adjust themselves to the lower level. The amount paid for insurance, is of course charged directly to a job. Therefore, any saving in the amount necessary for insurance means a saving to the job.

Analysis of Accidents on Construction Job. An examination of the accident records of Westinghouse, Church, Kerr & Co. for the first quarter of 1919 showed that there occurred on all the W. C. K. jobs during the months of January, February and March a total of 237 accidents. In 212 cases the services of a doctor were required to provide medical attention. Of the total number of 237 accidents reported, 147 were what are termed "No Time Lost Accidents." That is, each of these accidents caused no loss of working time beyond the remainder of the day on which the injury was incurred. The balance or 90 accidents were what are known as "Lost Time Accidents." That is, each accident resulted in the loss of working time beyond the day the injury was incurred. "Lost Time Accidents" are also referred to as "Tabulatable Accidents." That is, in the tabulating and classifying of accidents and the preparation of accident frequency and accident severity tables no account is taken of "No Time Lost Accidents" and "Lost time Accidents" only are considered.

The 90 "Lost Time Accidents" were divided as follows:

Fatal	1
Permanent partial disability	1
Caused loss of time of two weeks and over	33
Caused loss of time from one to two weeks	16
Caused loss of time of less than one week	39
Total	90

The total working time lost due to these 90 accidents amounted in addition to the fatal accident to a total of 1,734 working days. (Sundays are not counted as working days.) Expressed in terms of actual wages lost these accidents, without taking into consideration the fatal accident caused a loss of $9,775.

Accident Frequency and Severity Rate.—From the above figures it is possible to determine a definite accident frequency rate and an accident severity rate. The basis of all rates is necessarily the number of men exposed to the risk of accident. Since the working time varies the time factor must be reduced to a standard basis. Therefore, for this purpose an arbitrary unit of measurement has been adopted generally by all industries known as the "Full Time Worker." Each 3,000 man-hours per year represents one "full time worker." To calculate a yearly accident frequency rate for any particular concern the total number of man-hours worked during the year is divided by 3,000, which gives the number of "full time workers." Then since the total number of accidents is known it is possible to establish an accident frequency rate which is usually expressed in terms of the number of lost time accidents per thousand or per hundred "full time workers." The accident severity rate is usually expressed in terms of the number of days lost per "full time worker." By this method it is possible to compare the accident records of different industries and of different groups in the same organization. Based on the records for the first three months of this year W. C. K's accident frequency rate is 172 Lost Time accidents per year per 1,000 "full time workers."

The severity rate based on the same period of time is 3.5 working days lost time per year per "full time worker" exclusive of fatal accidents, of which there was one during the first quarter.

These actual figures may seem impressive to those who have never realized the extent of accidents in construction work. They are impressive and yet it is a fact as testified to by such statistics as are available and by general observations that W. C. K.'s accident rates are considerably below the average accident figures in the construction field.

For the sake of convenience, it is advisable to reduce these yearly rates to monthly rates, which is accomplished by simply dividing by twelve. That is, 3,000 man-hours divided by 12 yields 250 man-hours, which represents one monthly Full Time Worker. The total number of man-hours worked on a job during a month divided by 250 gives the number of Full Time Workers on the job for the month. The yearly frequency rate divided by 12 gives 14 Lost Time accidents per thousand or 1.4 Lost Time Accidents per hundred Full Time Workers per month, which represents the monthly frequency rate. In the same manner the monthly severity rate is 0.28 working days lost per Full Time Worker per month.

Cost of a Job in Terms of Injured Men.—Thus, with these monthly rates of 1.4 accidents per hundred "full time workers" and 0.28 days lost per "full time worker," an estimate of the cost of a job can be prepared in terms of injured men. Turn to a specific illustration in which it may be assumed that the job will require an average of five hundred men for six months. On an 8-hour basis with no overtime the number of man-hours worked per month would be approximately $500 \times 25 \times 8 = 100{,}000$ man-hours. This figure divided by 250 gives 400 "full time workers" per month. Applying the above rates to the assumed job we obtain a total of 5.6 lost time accidents per month with a resulting time loss of 112 working days. For the complete job lasting for a period of six months, the total accident cost will be 34 lost time accidents resulting in a total loss of working time of 672 working days not including the loss of working time which would result from any fatal accident which might occur. Thus, it is evident that this factor of the cost of the job is of first importance and should receive the most serious attention of those in charge of the work.

---

*From an article published in The W. C. K. Quarterly.

It is a fact that has been demonstrated by the experience of a large number of concerns in various lines that when vigorous positive efforts have been made to prevent accidents that the accident rates have been reduced [illegible] per cent and more. As a matter of fact, on one of the largest of our own jobs whose record was included in obtaining the above average W. C. K. rates the accident rates for each of the three months were less than half the average W. C. K. rates of 1.4 accidents per month per hundred full time workers and 0.28 days lost per "full time worker." Therefore it is certain that by earnest and sustained efforts on all the jobs to prevent accidents through the combating of carelessness and lack of foresight on the part of the men in the working forces by means of safety bulletins and personal instruction and cautioning by those who are supervising the work and by maintaining a constant vigilance in seeing that all unsafe conditions and practices are not permitted on the job the figures given above which represent the present W. C. K. accident rates can be cut in half.

Consequently, in preparing the estimate of the cost in injured men to complete a job the rate used should be taken at not more than half the present rates of 1.4 lost time accidents per hundred 250-hour workers per month with 0.28 working days lost time per 250-hour workers per month. Having established an estimate on this basis, all energies can be devoted to keeping the cost within the estimate.

Based on the experience of others and provided the proposition is tackled whole heartedly, there is no doubt but what the job will be completed within the limits of the estimate. Applying this plan to the job used in our illustration it means that when the completed structures are turned over to the client there will have been saved at least seventeen lost time accidents and a proportionate saving of 336 working days representing in wages saved almost $2,000. Yet this is but one average job. Providing that the same principle is applied on all of our work and it is possible to cut the present accident rates in half the saving in accidents in a year's time, assuming, for example, that there are employed during the year an average field force of 3,000 full time workers, would be about 278 lost time accidents and a proportionate saving of 1,950 working days representing in wages saved more than $27,000 without taking into consideration any fatal accidents.

Personal Appearance of Engineers

Some one asked Russel Sage, the multi-millionaire, why he wore shabby clothes. Mr. Sage replied that he wore them because he could afford to. When an engineer succeeds in piling up as many millions as did the late Mr. Sage, he also "can afford to wear shabby clothes." But until that time comes he should be careful of his personal appearance. The importance of this is pointed out in a recent issue of The Professional Engineer from which we quote as follows:

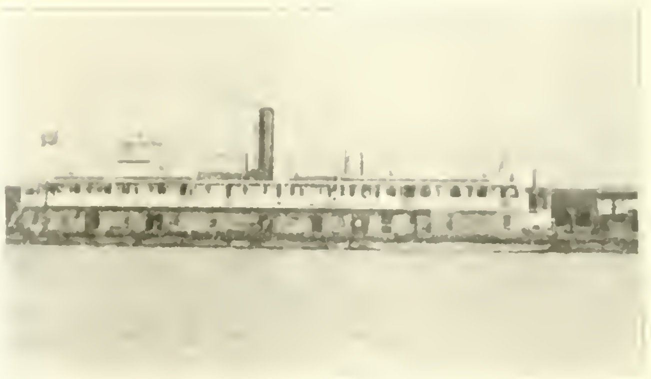
> The spirit of independence, the "American spirit" admired so much by all, has its advantages, but carried to extremes in the matter of dress, reacts decidedly to the disadvantage of the "independent."
>
> The rough and ready life of the field has its effects upon clothing and personal appearance as well as mental attitude. For example, the office engineer uses great care in his choice of clothing and general appearance and realizes the imperative necessity of his being well dressed, but the free and easy environment of the field breeds carelessness and some field engineers finally begin to neglect their appearance. On their occasional trips to the larger cities they compare unfavorably with their brother engineers of the office. Why? Merely because they unconsciously have become careless, or contemptuous of a white collar—the field has developed new ideas of independence regarding dress.
>
> Dress, carriage, all details of personal appearance, go to decide for or against an individual, and men who are capable engineers are often refused positions with some subtle excuse which really is a cloak to hide disapproval of the applicant.
>
> Clothes may not make the man but they are often the basis of initial impressions, and the result of first impressions with the majority of people is obvious.

Cost of Pipe Line Dredging in Open Gulf of Mexico

A description of the work done by the U. S. Dredge "H. S. Taber" on the Atchafalaya Bay Ship Channel under the direction of the U. S. Engineer Office, New Orleans, La., from Dec. 2, 1918, to April [illegible], 1919, is given by Mr. T. F. [illegible] Lipsey, U. S. Assistant Engineer, in a recent issue of The Military Engineer, from which the matter following is taken.

General Description of Dredge. The Taber is a 24-in. hydraulic dredge of the self-propelling, stern-wheel type, designed for work in the Arkansas River. The hull is of steel, 206 ft. 9 in. long, 44 ft. 4 in. wide, and 7 ft. deep, with 3 ft. 7 in. draft. It has one 24-in. centrifugal dredging pump driven by a triple-expansion engine. The suction pipe has what is known as a dust-pan head, with a system of water jets for agitating and disintegrating the material to be dredged. This dust-pan head is 30 ft. wide, and can be lowered to a depth of 11 ft. below the surface.

The dredge cannot be swung while in operation, but is pulled straight ahead, making a comparatively narrow cut. The discharge can be arranged so as to leave the dredge from either side a little forward of midship. The discharge line is a very heavy pipe, in 50-ft. sections, each on a turntable on the center of a steel ponton. The connections between pontons were rigid when the dredge arrived in this district, but were afterwards modified as herein described, to meet local conditions of exposure.


U. S. Dredge "H. S. Taber

The dredge was transferred to this district from the Kansas City District, leaving there on Aug. 20, 1918. The plant stopped at the mouth of White River en route to do some dredging, and arrived at Plaquemine, La., on Sept. 28, 1919. As the dredge was to work on the Atchafalaya Bay Ship Channel in the open waters of the Gulf of Mexico, it was decided to modify the ponton pipe-line by removing the large rigid flange connections and providing rubber sleeves in lieu thereof. The result was a pipe-line 500 ft. long in sections of about 50 ft., supported on small single steel pontons 12 ft. wide, 17 ft. long and 2 ft. 10 in. deep, all connected in the usual manner. In operation, this line proved to be one of the best ever seen, and was capable of standing the most severe weather and seas.

The work to be done was the dredging of a channel 14 ft. deep at mean low Gulf, and 200 ft. wide on bottom, for a distance of 15¾ miles in the Gulf, the inner end being 4 miles from the mouth of the Atchafalaya River at Atchafalaya Bay. This is a very exposed locality and the work had to be done during the winter months, in order to prepare the channel for ships being constructed at Morgan City, La., by the Emergency Fleet Corporation. The winter of 1918-1919, proved to be one of the worst in years, and in consequence of bad weather, and other unfavorable conditions, about 27 per cent of the available time was lost, as will be seen from the records herewith.

Method of Anchoring and Moving Dredge. This dredge is without spuds, and could not swing as is the usual case with a hydraulic dredge, hence a new scheme of anchoring and moving the dredge had to be devised. This was successfully done by a system of anchors arranged as shown in Fig. 1. A double drum hoisting engine was installed near the rear of the dredge, to operate the rear anchor lines. The forward anchor lines were operated from the main spool of the dredge swinging engines. When the dredge was in place for work, the anchors were placed as shown, the dredge was slowly but continuously hauled forward about [illegible] ft., making a cut as wide as the suction head, namely [illegible] ft. The dredge was then pulled back to the point of beginning, shifted sidewise the width of the first cut, and the operation repeated until the entire cut [illegible] ft. wide had been made. To make this cut usually took five operations, as the material was very soft and flowed freely from the sides to the suction head. The material was also drawn upwards from the bottom of the cut, making the average cut 2 ft. deeper than the 11 ft. depth of the bottom of the suction head. In some places the overdepth was as much as 3 to 4 ft., depending upon the depth of the material dredged, being greater for the shallower cuts.

The pile sinker, which was a part of the dredging plant when received, was anchored in a similar manner to the dredge, and was used to hold the pipe-line straight out from the side of the dredge, the whole line being connected to the dredge by a wire cable which passed along the tops of the pontons. This enabled the ponton line to be held securely when heavy cross seas were running. During very calm weather the baffle plate, which was placed on the extreme end ponton, was sufficient to hold the line straight. The system of holding and operating the ponton line is shown in Fig. 1. When the seas were so rough that dredging operations were suspended, the wire line holding pontons to dredge was turned loose, and the ponton line was allowed to swing around in lee of the pile sinker, so that it would ride the seas in safety. Due to the shoal water and the extreme depth of the soft mud, it was exceedingly difficult to handle the heavy anchors that were necessary to hold such a large plant in position against the prevailing high winds and rough seas. On several occasions these anchors sank 60 ft. into the mud.

To handle the anchors readily, it was necessary to use a large shallow-draft snagboat (the Denison) and a 50-HP. gasoline launch (the Beaumont). The powerful rigging for snagging on the Denison was very satisfactory for pulling these anchors out of the mud, although the large house combined with the shallow draft made the boat rather unhandy in the wind and sea. However, on the whole, it proved fairly satisfactory. An additional 40-HP. launch was provided to carry the personnel, mails, and supplies to the dredge.

The site of the work was from 30 to 45 miles from the base at Morgan City. All men, coal, and supplies had to be brought from this locality of two coal barges and two water barges. It should be stated that this work was done during the period of the worst emergency of labor conditions, due to war and draft, and when it was almost impossible to secure men of experience or those who were even worth their hire. Ofttimes they would go to the plant, get something to eat, and return by the next trip of tender to Morgan City. Some trouble was also experienced with steam engineers who demanded the rates of pay adopted by the Steam Engineers' Association. This was overcome, however, by getting the chief engineer to stick, and by having all others rated as dredge engineers, as this designation did not require a license. In addition to this, the epidemic of influenza was at its height during this work, and the dredge at times was almost a hospital.

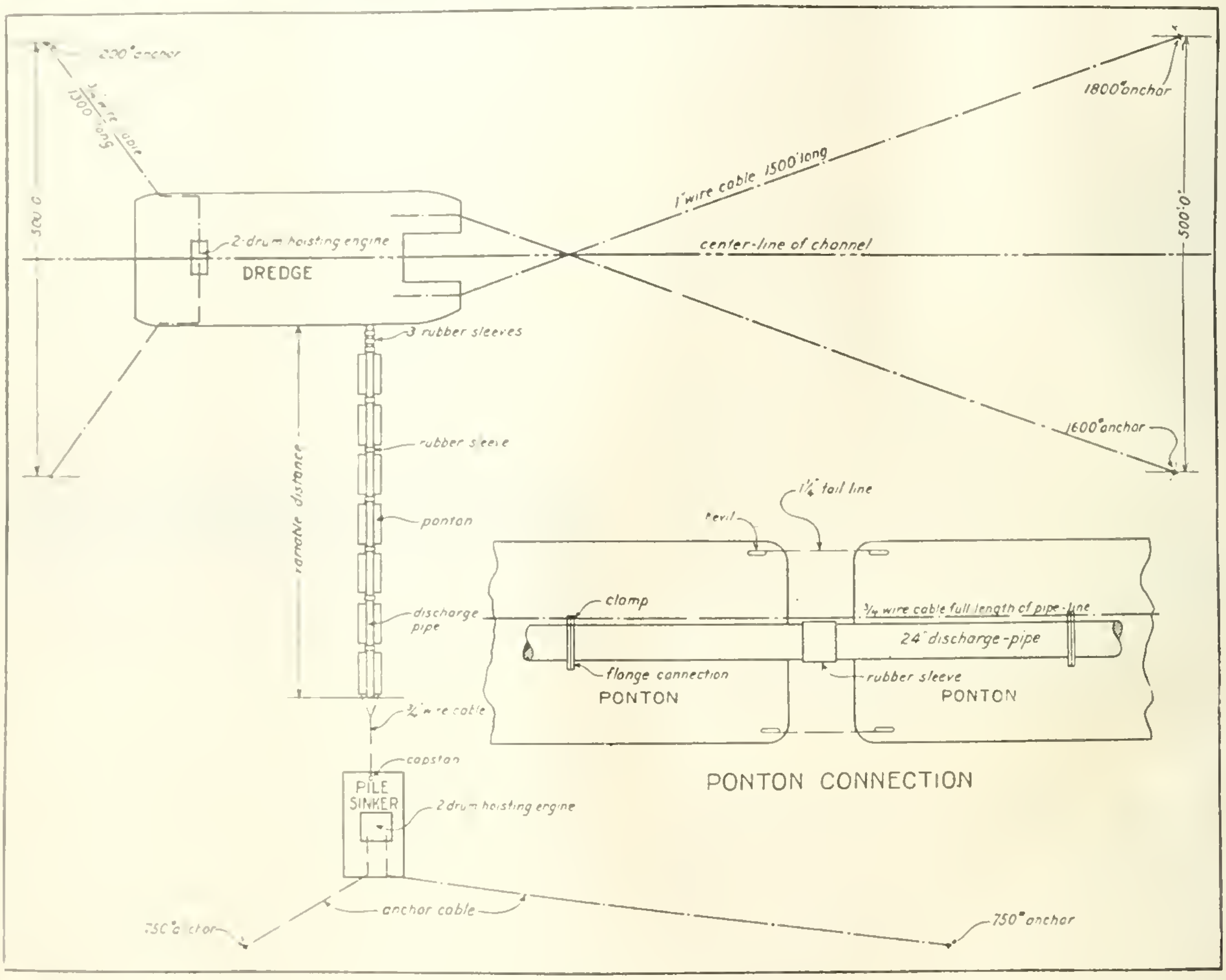


Fig. 1—Layout of Plant Showing System of Anchoring and Moving Dredge, Also Method of Holding and Operating Ponton Line.

Plant Operation and Personnel.—The plant usually was operated with three crews working eight hours each, but due to shortage of men, the average was not over two crews for continuous service.

The number of men and rates of pay on each plant are shown in Table 1. The ordinary ration allowance was 60 ct. per day per man.

The material handled was a very soft mud, mixed with shell in certain portions of the channel. A mechanical agitator was not found necessary, as the jets sufficiently disintegrated the material, and rendered it [illegible] enough to pass readily to the suction.

Table II shows the time lost from different causes, and also the time actually working and pumping.

Costs.—The total cost of the work from the date of arrival of the plant at the site, Dec. 2, 1918, to the date of completion, April 5, 1919, including all lost time from all causes, was $59,815. The total yardage removed figured on the theoretical cross-section of 14 ft. deep at mean low Gulf and 200 ft. wide on bottom, with side slopes 1 on 1 and

Fig. 2—Buffalo Plate and End of Pipe Line.

1 foot overcut, was 2,480,721, costing 2.4 ct. per cubic yard. The actual number of cubic yards removed was 3,2[illegible], costing 1.9 ct. per cubic yard. The above yardage was figured on actual cross-sections taken before and after dredging.

The total cost of bringing plant from the Kansas City District and altering it for work on the channel was $1[illegible]. The total gross cost of the work, including all expenses to this district, was $[illegible],024, or [illegible] per cubic yard on the theoretical cross-section and [illegible] on the actual section.

The largest day's work was on March 12, 1919, when the dredge excavated a channel of the above dimensions 1,000 ft. long, removing 82,900 cu. yd. at a field cost of $375, or 0.42 ct. per cubic yard. During this [illegible] period the dredge lost 3 hours and 10 minutes shifting anchors and 4 hours dropping back to take up new cut and shift over. The pump was actually running 16 hours and 20 minutes. "Field cost" includes payroll, subsistence, fuel, engine room and miscellaneous supplies.

In 1915 the hydraulic dredge Gulfport (20 in. pump) worked in this same channel, removing nearly 2,000,000 cu. yd. at a field cost of 1.04 ct. per cubic yard. The following is a comparison of the work of the two dredges:

	Taber Cu. yd.	Gulfport Cu. yd.
Average dredged per hour pumping	[illegible]	2,020
Average dredged per hour effective working time	[illegible]	[illegible]
Average dredged per working day	11,0[illegible]4	10,9[illegible]
Maximum dredged in one month	8[illegible]2,[illegible]12	1,0[illegible]

TABLE II—DISTRIBUTION OF TIME.
Dec. 2, 1918, to April 5, 1919

	Hours.	Minutes.	[illegible]
Time at work—			
(a) Pumping	556	55	[illegible]
(b) Handling pipe-line	10	2[illegible]	[illegible]
(c) Handling anchors	377	11	[illegible]
(d) Moving dredge	112	26	[illegible]
Total	1,056	[illegible]	[illegible]
Time lost from work—			
(a) [illegible] position of plant	6	50	[illegible]
(b) Bad weather	811	[illegible]	[illegible]
(c) [illegible] at nights	296	00	[illegible]
(d) Waiting [illegible]	112	15	[illegible]
(e) Ordinary repairs	75	11	[illegible]
(f) Miscellaneous, taking on supplies, etc.	159	17	[illegible]
(g) Sundays and holidays	504	00	[illegible]
Total	1,9[illegible]	02	[illegible]
Grand total	[illegible]	00	[illegible]

TABLE I—AUTHORIZED NUMBER AND PAY OF EMPLOYES ON U. S. DREDGE "H. S. TABER."
(2 crews.)

No.	Position	Total pay (mo.)
1	Master	$ 1[illegible]5
1	Mate, first	1[illegible]5
1	Mate, second	11[illegible]
1	Mate, third	[illegible]
1	Steam engineer, chief	[illegible]
1	Steam engineer, 1st asst	[illegible]
1	Steam engineer, 2nd asst	[illegible]
1	Steam engineer, 3rd asst	[illegible]
1	Engineman (operator), first	[illegible]
1	Engineman (operator), second	[illegible]
1	Engineman (operator), third	[illegible]
2	Firemen (pile sinkers)	[illegible]
1	Steward	[illegible]
1	Blacksmith	[illegible]
1	Cook, first	[illegible]
1	Cook, second	[illegible]
9	Firemen (marine)	[illegible]
3	Stokers (water tenders)	[illegible]
3	Stokers (coal passers)	[illegible]
3	Oilers (marine)	[illegible]
1	Waiter, first	[illegible]
1	Waiter, second	[illegible]
1	Waiter, third	[illegible]
3	Deckhands (boatswain)	[illegible]
14	Deckhands (ordinary)	[illegible]
1	Gasoline engineer (Nezpique)	[illegible]
1	Deckhand (boatswain) (Nezpique)	[illegible]
1	Gasoline engineer (Beaumont)	[illegible]
1	Deckhand (boatswain) (Beaumont)	[illegible]
1	Machinist	[illegible]
1	Carpenter	[illegible]
62		

AUTHORIZED NUMBER AND PAY OF EMPLOYES ON U. S. STEAMER "DENISON."
(1 crew.)

No.	Position.	Total pay (mo.).
1	Master	$ 150
1	Mate	105
1	Steam engineer	125
2	Stokers	7[illegible]
4	Deckhands	7[illegible]
1	Cook	7[illegible]

Note: Subsistence also furnished all hands.

Protection of Mine Timbers with Magnesia Cement

Where mines are located in out-of-the-way places where timber is scarce and its price high, the problem of protecting it from fire risk is of considerable practical importance. Scarcity of timber for mining purposes is commonly met with in the more arid parts of the country, where, also, mine timbers are most likely to become dry and inflammable, and where, therefore, the risk from fire is accentuated. Any effective and cheap method of securing adequate protection of such timber at the lowest possible cost is worthy of careful investigation. The use of magnesite cement has been suggested in this connection. In a Monthly Report of Investigations of the U. S. Bureau of Mines, Mr. W. C. Phalen gives the following information on this material and its use for the aforementioned purpose:

The elasticity of magnesite cement is the outstanding quality which makes it desirable for exterior work. It also possesses the ability to adhere to all materials in a marked degree. Its freedom from expansion and contraction after setting is one of the principal reasons for its adhesive quality. It may be applied to old brick or stone walls even though they have been repeatedly covered with paint, and the quality of adhering to wood makes it possible to secure a weatherproof protection to the wooden casings and trim of exterior openings. The quality of adhesion and elasticity is easily proved by applying a ½ in. layer to a 1-in. board, which has been first covered with metal lath. Such a board, about 8 ft. long, may be repeatedly deflected about 3 in. in the center without breaking the bond to the board, or causing any cracks to appear in the magnesia cement. The ability to resist fire as well as the possession of insulating qualities are also desirable characteristics of magnesia cement stucco.

Magnesite cement stucco should be applied in two coats, each [illegible] in. thick on various surfaces such as wood lath, metal lath, sheathing board, brick, hollow tile or stone; care being taken as regards the presence of lime unless the same has been rendered, or become inert as with very old walls. The first coat made up to a consistency that works easily under the trowel, is applied in the usual manner. No water should be added to the liquid chloride as it would alter its density, and injure the work. The second or finishing coat is then applied. The aggregates are different in each, and no other dry material should be added to them as they come to the trade. The cement may be applied in zero weather without damage. Setting is quite slow under such conditions, but the cement ultimately becomes hard. It should always be applied to a dry surface excepting that under certain conditions it is desirable to apply a solution of magnesium chloride before using the stucco.

The temperature is of importance. If the temperature is over 50° F., only so much of the first coat should be applied in one day as can be covered with the second coat. In this way, the finishing coat is applied before the first coat has become hard. If the temperature is below 50° F., the finishing coat can be applied 24 hours after the first coat is applied.

College Men in Railway Work

A short time ago Prof. Frank Haigh Dixon of Princeton University sent a letter to a considerable number of railway executives representing both large and small systems and located in various parts of the country, inquiring concerning the opportunities at the present time in the railway field for college men. The inquiry in substance was: Does the college trained man, other things equal, stand any better chance of advancement in the railway industry than his untrained competitor? The following interesting summary of the replies to this inquiry is given by Prof. Dixon in a letter to the editor in the July 2 Railway Age:

On the one hand there is a considerable number of leading executives who believe unreservedly in the college man. Most of them are putting their ideas into practice and are taking college men into their service, the larger number of men being drawn, however, from the engineering schools rather than from the purely academic institutions. To be sure these executives made the obvious point that there is no short cut for hard work, that the industry is becoming stabilized as it becomes more closely regulated, that the opportunities for rapid advancement which were open in the pioneer days are now closed, and that the young man must accept a greater stability in employment as an offset for the larger rewards offered in competitive industry. Yet these replies all insist that the opportunity for large public service and for employment that will develop the capacity for leadership was never greater than now. The following statement from one of the letters is an admirable summary of this point of view:

> My own belief is that the complexities, as well as the scope, of the matters handled by the railway officers in the higher executive positions are now such that these positions are not likely often to be filled other than by men who have had such an orderly training of the mind as is secured through a college education, though there will happily always be those coming up in the service who, through correspondence schools, private reading and by recourse to other agencies, will similarly fit themselves for the discharge of their duties.
>
> I have always felt that the railroad service offered a splendid opportunity to the virile type of man who enjoyed an outdoor life and intimate contact with his fellows, and that the service would be immensely benefited could a stream of men of this type, who had had football, baseball or crew and other athletic training, be inducted. I have introduced a good many of these men into the service and almost without disappointment.

But the discouraging answers considerably outweigh the favorable ones in number. One discouraging note running through many of the letters grows out of the uncertainty or pessimism of their authors as to the future of private operation. One is hardly surprised at this pessimism. Moreover, I thoroughly agree with these correspondents in hesitating to recommend railway service to the college graduate if we are to have permanent government ownership and operation. Until there is a thorough overhauling of the civil service, no informed college teacher can conscientiously send any virile young man into that deadening atmosphere.

Again many of the letters show a distrust of the college bred man—an attitude common among business men in general 15 or 20 years ago, but rapidly disappearing in manufacturing, banking, foreign trade and other fields which the college men are entering in large numbers. One writer warns the college boy that he must not expect to get by on his diploma and good clothes. There is a general feeling that he is not willing to begin at the bottom and work up, that he has not the patience to travel the rough road, and that before his apprenticeship is complete he leaves the service to seek other lines, where advancement is more rapid, where [illegible] conditions are more congenial and where the compensation is larger.

One of the ablest of our railway executives who appreciates fully the latent capacity of the college man, writes in this discouraging vein:

> We have made an earnest effort to attract into our service men of training and education with the purpose of giving them an opportunity to [illegible] but on the whole the experience has not met w[illegible] [illegible] on the purely [illegible] a vigorous [illegible] The [illegible] roving and [illegible] the years of [illegible] There are few [illegible] opportunities for [illegible] I refer to have been brought up. We find that these things test character beyond the endurance of many men who are fitted by ability to succeed, the more because they see their college associates leading a more comfortable life and apparently succeeding quite as well in the cities.
>
> It is a difficult problem and one which gives me sincere concern, as every failure sets back the work by discouraging the practical railroad men who have worked through many hardships to positions of responsibility and are not predisposed to believe that college education is a short cut to the success they have themselves achieved with travail and self-denial.
>
> As a result of this experience I am loth to ask our managing officers to put forth again their effort at training.

For the situation just described, is the college man altogether to blame; and if not, where lies the trouble? So far as it is true that the young man lacks determination, avoids hard work, looks for the quick and easy road to fortune, we of the colleges are at fault. But there is this encouraging feature in it: we are aware of our shortcomings and are already taking steps to correct them. The business departments and schools affiliated with the colleges have done much to dignify business and alter the college boy's attitude. A marked change in this respect has gone on in the last decade and is still proceeding. Moreover, the movement is under way for the creation of vocational departments in the colleges that shall study the peculiar needs of each business and the aptitudes of the graduates for the respective careers.

But what have the railways done in the way of developing personnel departments, of fitting men into their proper places, of recognizing talent and making use of it? Here is a group of selected men, selected when they enter college by the intellectual test of entrance examinations, and slected again when they decide to enter the railway service after four years of training, by instructors who have followed them closely. It is the customary thing for the successful business man to tell the college boy that he must begin at the bottom and work up, which is true to a degree, but not to the extent that they have in mind. If his four years' training means anything, his apprenticeship, when guided by intelligent and sympathetic oversight, should be materially shortened. The college man, if he seeks a career in the railway industry, should not of course flinch before the hard work, the long hours, the geographical isolation, the relatively slow advancement, and the relatively small remuneration of the early years, but is he not entitled to the sympathy and encouragement of his superior officers, and the opportunity to show his right to advancement in the service?

This raises one of the difficulties most frequently referred to by the correspondents—the standardization of labor conditions, due to extension of union organization and control. Many executives express the very definite opinion that the college man cannot advance in the face of the seniority restrictions of union labor. One of the western executives writes: "With us our men come out of the melling pot and are fitted to their conditions out here, and in the West, at least, a man could not have a greater handicap than to be started in his work virtually at the bottom, but be labeled as a potential officer."

I do not profess competence to solve this problem and it may be that the increased strength of unionism, growing out of the experience of the past three years, has made any plan for apprenticeship training of prospective officers impossible. But I have a feeling that the case is not so hopeless; in fact I wonder whether in many instances the block to advancement is not rather the hostility of a minor officer who is prejudiced against "the college feller," rather than the restrictions of trade-unions. I have a hope that if the problem were frankly tackled a way would be found out of what seems to be an impasse.

And my own concern is not primarily for the college man, who has many other and at present more attractive opportunities, but for the future of the industry itself. "American Railroads," published by authority of the Association of Railway Executives, states as one of its principles without the observance of which government ownership is unavoidable, "that the railroad industry should attract and retain the ablest type of men."

When I observe, as I have for many years, the appearance every spring at the college of the "scouts" from various business enterprises, picking off the leading men of the senior class, when I note that the banking interests are now seeking college men because they [illegible] to train bankers and not bank clerks.' I cannot help [illegible] whether in the long run the railway industry w[illegible] behind in the race, if it does not find some way to [illegible] advantage of the trained mind with its capacity of [illegible] problems in the large and solving them on the ba[illegible] fundamental principles, rather than by making a [illegible] of resorting to rule of thumb methods learned in the [illegible] of experience."

I close with a quotation from a[illegible] who has put this thought into practice and who [illegible] in it without reservation:

> There can be no doubt of the [illegible]. The [illegible] who begins his work with an intensive [illegible], other things being equal, he will go ahead [illegible] than the man who lacks that great initial [illegible] the technical branches of railroading [illegible] of the productive industries, we have [illegible] the preliminary training of a college or [illegible] no longer looked upon merely as an ad[illegible], practically speaking, a necessity for the [illegible] at a place in the executive forces. Nor [illegible] the fact that a few men of extraordinary ge[illegible] to overcome the handicap of a lack of [illegible]. For the typical young American, who is not a genius [illegible] and ambition, nothing, in the fierce com[illegible] life can entirely make up for the lack [illegible]. This applies to railroading just as fully as to [illegible] and mining industries.

The speculative area has now passed. With the [illegible] of the country, the opening to agriculture of nearly all [illegible], the placing of industry on a permanent basis, and in [illegible] years the firm establishment of public regulation as [illegible] policy accepted by all, the controlling factors have [illegible] to remove railroading almost wholly from the realm of spec[illegible] enterprise, at least as far as those who work in it for salaries are concerned. As a result, the work of the railroad officer has become one of the most highly stabilized of the professions from the viewpoint of remuneration and certainty of employment.

To a young man of ability about to graduate from college and confronted with a choice of professions, I would, therefore, say that railroading offers a more certain career than most branches of commerce or industry, with less likelihood of suffering through the mistakes or wrongs of others and also with somewhat less probability of gaining the very highest monetary return.

However, for the young man with a good mind, quick brain, sane common sense and thorough training in his college, who desires to enter upon a life service of great activity and unsurpassed interest, which, with capacity, devotion and hard work on his part, will always pay him a satisfactory living, and hold reasonable assurances of an excellent, if not excessive, salary in his maturer years, I know of nothing better to recommend than a railroad career.

It is far from an easy life. On the contrary, few occupations demand more absolute subordination of personal interest to duty than does the work of a railroad operating officer. It is a career that will involve many trying experiences with long and often irregular hours of arduous duty, but it has its compensations. Few careers present a greater variety of problems, or are better calculated to prevent the mind from getting into a rut, and few present greater opportunities for travel and association with men in other lines of business or for studying human nature in general in all its aspects.

Finally, the young man who chooses the railroad profession will have the great and lasting satisfaction of knowing that he is earning more than his own living every day and that he is engaged in one of the most indispensable forms of service toward his fellowmen to which his own life could be devoted.

Massachusetts Highway Engineers Get Salary Increase.—As a result of the efforts of the Boston chapter of the American Association of Engineers, the employes of the state highway division of the Massachusetts department of public works have been granted an increase in salary averaging 20 per cent and effective on June 1, 1920. Other engineering departments were given an increase which is reported to average about 12 pr cent.

New Trans-Andean Line proposed.—The President of Argentine has asked the Argentine Congress to consider a proposition to extend the state railways, constructing a line from Salta to connect the northern provinces of the countries with the Chilean port of Antofagasta or with that of Mejillones. The nearest port by rail from Salta is now Santa Fé, distant from Salta about 700 miles and situated on the Parana River 300 miles upstream from Buenos Aires. The proposed railroad would bring Salta within 350 miles of the Chilean port, making a saving of 350 miles of railroad haul. The total cost of the project is estimated at $25,000,000.

Laborers—and Other Laborers

[illegible]

[illegible]

The new schedule [illegible] in New York City, which gives [illegible] an average of more than $1 per hour, calls to mind some of the varying features of handling building [illegible] in different sections of the country. When the present attitude of practically all organized labor is extremely dictatorial, it is not much more of a problem than the shiftlessness frequently seen in certain types of unorganized labor.

Some time ago on a job in Virginia, an effort was made to use local negroes as common laborers. It was at a time when there were more jobs than there were men to fill them, and with the usual carefree lack of responsibility of the typical darky, these men would move about from job to job without giving any notice and frequently without a discernible reason. They seemed to be concerned only with what was going to happen within the next 24 hours, being as continually hungry as the proverbial doughboy, and thinking only of meals and sleep.

About the only way in which they could be kept steadily at work was to keep them in debt to the company. This method, which has been a prolific cause of industrial friction for generations, was resorted to only as a last measure and when all other means of holding the men to their work had failed. If the pay officer had advanced money for railroad fare or credit for food or other necessities, he had a hold on the men, and they knew that they would not get any money until they had woked out the debt. If, however, one of these men ever found himself in possession of $2 or $3, it became absolutely necessary to get that money spent before he would do another lick of work.

Another method adopted in holding the men on the job consisted in establishing a restaurant where they could obtain food at the cost of the raw materials. Here the men could get far better food, well cooked, than at any other place in the neighborhood, and for a much lower price. As this was run largely on the charge basis, against earnings, it formed an additional tie between the company and the men. Bunk houses where they could be sure of being dry and comfortable were another potent aid in keeping them satisfied.

It was quite impossible to drive the darkies, but those who understood their mercurial nature could easily lead them, particularly where the leader had a faculty for mimicry or other forms of amusement. One timekeeper who was an excellent amateur ventriloquist, kept a whole gang working at top speed so long as he could keep them laughing. As soon as this impetus was withdrawn they slowed down to the quarter speed or less, for which they are frequently famous.

The situation in Virginia was improved materially by bringing in two or three drafts of negroes from Georgia. These fellows were much better workers, did not have to be watched every second of the time, and showed more intelligence than the average Virginia darky. Consequently it was easier to handle them, and smaller effort could produce the same amount of work. As no distinction with regard to pay could be made between the two groups, however, the use of good men alongside utterly inefficient men did not always produce a happy combination.

The rate per hour for a 10-hour day was, at this time, some [illegible]7 ct. This was more than the darky needed for his next day's meals and shelter. Consequently he formed the economic habit of working about four days per week and utilizing the balance of the time in spending his earnings. As an offset to this, an attempt was made by means of a special bonus to keep the men working more steadily. Each man who stuck to the job through the entire 54 hours of the week received an additional 5 ct. per hour or $2.7[illegible] for the week. This device was only partially effective, for a mere dozen men out of 12[illegible] on that job earned the bonus.

Even when the men were working, or supposed to be working, they were found exercising all sorts of ingenuity to avoid making every movement effective. One man was discovered down near the river bank watching somebody shooting snipe. Others would discuss long and earnestly how they should go about performing the simplest sort of tasks and which end of a plank each man was to handle. This did not involve anything of a quarrelsome nature, but it was distinctly discouraging to a supervisor accustomed to the snappy work obtainable in most places in the North.

Another form of labor with which difficulties of a different character were experienced is the so-called "padrone." Greeks, Spanish, Italians and Albanians all work in this principle, Spanish and Albanians, particularly so. The padrone or leader looks after a considerable group of men, acting in effect as their business agent, and delivering the entire crew to any job which pays high enough for his and their services. The men will not work independently of the leader, nor can they be hired away from him. If anything displeases the padrone, he will take his whole gang away to the next job. This gives the employment manager gray hairs in trying to fill the gap before there is a chance to hold up other parts of the job, due to the lag in the work which was being done by these men.

These padrones are very jealous of their privileges and usually want a good deal more for their individual services in keeping the men lined up, than they could possibly earn as laborers themselves. The Albanians are particularly difficult in this respect, and the whole system leaves very much to be desired.

Attempts have been made at various places in the South to use as laborers some of the so-called "poor whites." Little success is obtained in this effort, because of the extremely poor quality of human being represented under this term. Most of the men seem physically incapable of real hard work and are temperamentally incapable of attempting it. They are illiterate and densely ignorant of the many things which most men have known since childhood.

Skilled labor in Southern fields is extremely scarce. The Aberthaw Construction Co., when doing work below the Mason & Dixon's Line, has found it advisable in most instances to import the bulk of skilled labor from the North. Carpenters, masons and others whose work is high grade are, in general, much better trained in the North, and can be relied upon to do so much better work, that it has been found futile to attempt to rely exclusively on the local product.

When it comes to bosses for the negro laborer, however, these are almost invariably drawn from the local field, because the natives understand how to handle the black man, with special emphasis on the Southern black man, far better than any Northerner can possibly know. They josh him and coax him along in a way which appeals to his sense of humor, and by keeping up a continual chatter are able to get results which would be utterly impossible by the methods adopted in the North with Italian and other foreign labor. The same form of good-natured raillery often disarms complaints when made, and causes the previously disgruntled darky to forget his troubles entirely and go off with a grin on his face.

It will be evident from the above random remarks that geography has a good deal to do with the handling of labor in building construction. Knowledge of local characteristics and of various types of men is essential if results are to be obtained. Even under the best of conditions, however, with adequate knowledge and familiarity with the men, there are many cases where the kind of result desired is unobtainable no matter how great may be the effort to get it.

For instance, some years ago, when Mexican labor was quite content with 50 ct. per day, an attempt was made to increase the production per man by raising the rate to $1. The result was a prompt disillusionment. The 50 ct. had been ample to permit the men to live; hence with $1 per day they worked only half as many days and loafed the rest of the time. The employment manager, therefore, who expects to obtain similar results from his men regardless of local conditions is likely to be disappointed whenever he gets into a region where negro or Mexican labor has to be depended upon to any considerable extent.

Electric Locomotives for Swiss Railways.—The first of the 11 electric locomotives ordered by the Swiss government in the latter part of 1918 for the federal railways (Guebe Valley and Berne-Schwarzenbourg lines) has just been delivered by the builders, the S. A. Brown, Boveri & Cie, Baden

Closure of a Flowing Crevasse in the Beulah Levee

The successful closure of the Beulah Levee Crevasse, Bolivar County, Mississippi, marks a new era in the handling of such situations on the Mississippi River. The method used was generally the same as that employed in closing the Colorado River crevasse, but was, at Beulah successfully applied on the Mississippi River for the first time.

The closure of a crevasse in the Mississippi Levee while water ran through it, has been of exceedingly rare occurrence. In most cases the inaccessibility of location makes it impracticable to use steam equipment, and the only accessible earth is in the small part of the levee that is above water, with no rock available. Experience has usually been that by the time equipment, material and forces can be assembled and work gotten well under way, the flood has well nigh subsided.

An interesting description of this work is given by Mr. T. L. Dubbs, Superintendent, Vicksburg Division, Yazoo & Mississippi Valley R. R., in the Journal of the Engineers' Club of St. Louis, from which the matter that follows is abstracted.

Conditions at Beulah were peculiarly aggravated. The levee gave way in April, 1912, forming a crevasse 3,400 ft. wide in a levee 23 ft. high. A large territory (about 2,100 square miles) was submerged until late in the planting season and the resulting money loss to planters, mills and railroads was very great. By a combination of unfortunate circumstances, an unusually early rise of the river in January, 1913, found an open gap in the new levee, which was then under construction around the crevasse. A large part of the district, struggling to recover from the inundation which it had suffered but nine months before, was again flooded. There remained three months or more of the usual flood season when a second rise might reasonably be expected, subjecting this area to a third overflow within 12 months. It was imperative to close this gap, if possible, before another rise should come.

The Yazoo & Mississippi Valley R. R. had been a heavy sufferer from the two floods and would be from the third. This road has a main line 2½ miles east of the new crevasse, over which its through passenger trains between Memphis and New Orleans are run; another main line, about 15 miles further east and a branch between the two, besides other branches in the path of the waters from the break. It was of special interest to the railroad to prevent another flood from going through.

On the evening of Feb. 6, the terms of a contract, by authority of the Mississippi River Commission were agreed upon by the United States Engineer Officer and the railroad's representatives, providing that the railroad company, as agent for the United States Government, should close the crevasse. The railroad was to be paid the cost of all labor and all material, plus a small percentage to cover overhead charges. At this time there was still a large volume of water flowing through this break.

Mr. Dubbs, Superintendent of the Vicksburg Division, Y. & M. V. R. R., took personal charge for the railroad company and on Feb. 7, he had materials and equipment moving towards the break. On Feb. 8, track laying was begun on the spur track running from the main line of the railroad near Beulah station, to the break.

During the first three days of track laying, it rained constantly, during the remaining days it was rainy and very wet. The men worked in mud and water a foot or more in depth, laying the track across the cotton field between the railroad and the levee (a distance of 2,200 ft.). From the point where the spur track reaches the levee, it was built on the banquette, which was rounded in advance of the track laying with road graders. On most of the line, the ties were laid on "slabs."

Ties were loaded on barges at Rosedale, floated down beside the levee, and laid in place on the banquette, by Mr. Lilly, U. S. Junior Engineer, with a force of government laborers, in advance of the steel gang. On Feb. 16, 8 days after track laying was begun, and 10 days after the work was decided upon, the 4 3-10 miles of track to the north end of the break had been completed. The track was ballasted with cinders.

On Feb. 17, pile driving was [illegible] a track pile driver at the north end of the break [illegible] a creeping pile driver with piling and bridge [illegible] had been floated on barges to the south side of the [illegible] driving from that end was begun on Feb 20 [illegible] current running through the break for several [illegible] removed all material in the surface strata and left [illegible] stiff "gumbo" or "buckshot" bottom The averag[illegible] pile was [illegible] ft average penetration 20 ft., high[illegible] ft from rail to ground Untreated pine piling wa[illegible]

Eighty-three bents were driv[illegible] five piles each, the other four piles The [illegible] trestle is 1,140 ft The pile drivers worked day [illegible] and the trestle was completed March 3, 25 days [illegible] contract was made, and 12 days after the track [illegible] the break.

When the first piles were drive[illegible] difficulty was experienced because of the swift cur[illegible] at a depth of 16 to 25 ft. Several piles, bein[illegible] against the pile driver leads before striking bottom, [illegible] off at the bottom of the leads and tumbled ove[illegible] the current The water was falling, however, and [illegible] pile driving was completed in dead water an average of [illegible] feet

A number of cars of rock had been shipped in from quarries in Kentucky, Alabama and Arkan[illegible] and were standing on available sidings for many mile[illegible] the railroad About half the cars contained "rip-rap" [illegible] and half of them quarry run, some pieces being so large as to require shooting in the car to unload them. The large quantity needed in a limited time made it necessary to take any size that could be had most promptly All rock was handled in bottom dump cars The top of the trestle was built open so that the cars could be dumped.

On March 3 the day that the trestle was finished the dumping of rock was begun. The last of 1,102 cars (about [illegible] yd) of rock was dumped about April 2, and the rock was then topped off even with the ties, with 1,000 yd of gravel This gravel proved invaluable, as the very stiff mushy buckshot dirt could be cleaned off its surface with a facility that would not have been possible on the exposed rock fill The gravel also gave firmness to the surface

The required quantity of rock was ordered on the basis of [illegible] to [illegible] slopes Instead, the rock filled assumed about 1½ to 1 slopes and to make the available supply reach up to the track the top 6 ft of the bents (below the caps) was boxed in The plank walls of this box were tied together, midway between bents, by ¾ in. wire cables, doubled, passing around 6 by 10 verticles, outside of plank, and twisted taut

The second 1913 rise came through the old crevasse and against the new levee and rock fill on March 27, before the rock was all in place Flow through the rock fill was free at a moderate velocity, not sufficient to further erode the buckshot bottom As the water continued to rise, the flow increased, but the natural drainage channel accommodated most of the water that flowed inland from the crevasse, so that comparatively little low land was submerged, no cultivated land of any consequence. Mr. Dubbs estimated that before any earth was dumped over the rock fill, 1½ per cent as much water passed through, as would have gone through the gap, if entirely open

On April 3, the first earth was dumped on the river side of the trestle, and from that time earth was hauled in and dumped in constantly throughout the rise and fall of the flood

From the time that the dumping of earth began, the water on the land side of the fill began to recede very slowly at first By April 14, the flow through the rock fill was practically stopped, and the low lands were relieved of water. As the earth became saturated, much of it was drawn into the rock fill, some passing through and forming mud bars on the land side, estimated 8 to 14 ft high and [illegible] to 100 ft wide

The crest of the flood wave reached Beulah April 20 up to April 30, when there had been 1 ft fall from the crest and the strain was considered over, 7 1[illegible] cars or about 80,000 yd of earth had been dumped.

The earth was loaded with two steam shovels The nearest location which afforded suitable material and drainage facilities for shovel pit, were just south of Rosedale, about ten miles from the crevasse. Five and four-tenths of the haul from this pit was on the railroad main line (single track), operating eight regular trains a day The pit layout sidings, telephone block system on the main line and on the spur line, erection of temporary coal house and water tank were all carefully planned by Mr [illegible]

The pit ground was [illegible] ft wide and [illegible] ft long. The pits were carried 7 ft deep The earth is a stiff buckshot that handled in clods, frequently [illegible] the size of the shovel This was a great advantage because these large clods rolled directly to the toe of the slope, otherwise percolation might have been checked elsewhere before it was at the bottom, thus inviting undermining of the [illegible]

The steam shovels were [illegible] Atlantic type The cars used for earth were Haskell [illegible] side dump ballast cars A full train carried 20 After the [illegible] became soft from seepage trains carried from [illegible] to [illegible] cars Earth was unloaded on the water side by Barnhardt side plows and Lidgerwood unloaders

Steam shovels and trains were operated 24 hours per day Marine lights and Millburn acetylene gas lights were used

The actual yardage placed in the crevasse was as follows

	cu yd
Earth	[illegible]
Rock	[illegible]
Gravel	[illegible]

All trains, including the regular trains on the main line and the material trains on the spur were handled by the telephone manual block system There were four block stations with telephone houses and sidings on the main line and three on the spur line Train movements were controlled by train directors stationed at the steam shovel yard with block signal men at block stations, 24 hours per day

Cambered Tie Plates

Mr A Morrison, writing in the "Railway Review," questions the advisability of using cambered tie plates and quotes his own experience and observation bearing upon the subject His short discussion follows.

The theoretical consideration of the wave motion of the rail would seem to require a bearing surface that will in some manner conform to this movement. The extent of this movement depends upon the weight of rail, intensity of wheel loads and upon track conditions With the use of light rails, the wave movement is undoubtedly greater than with heavy rails, and the physical track conditions are correspondingly improved, with the latter.

Some of the railroads now use extra heavy rails which has greatly improved the line and surface of the track. Even though the wheel loads are the maximum, the reduction of the wave movement is naturally the result Still, in view of these facts, cambered or curved-surface tie plates are being used, much to the detriment of the life of the tie plate.

If any maintenance of way engineer is in doubt as to whether the flat top, cambered or curved tie plate is the correct practice, he can readily satisfy himself by taking out of the track a tie plate, here and there which has been in use under severe conditions for three or four years, test the surface with a straight edge, and thus determine whether the tie plate is being worn to conform to the curved surface or is worn level or flat

The writer has done this and has found that the plates which originally had cambered or curved surfaces have worn level, and in no plate was there any indication of wear that might be considered to conform to the wave movement of the rail A plate having a camber of 1 16 in was completely worn off, leaving the plate with a straight surface, and this should be especially noticed, 1 16 in thinner at the center than at its sides

If any benefit is to be derived by using a plate that is cambered or curved giving a bearing point at its center, it would be to prevent rocking by a central application of the load While this may be good practice with light rails poorly maintained, it is uncalled for where heavy or extra heavy rails are used. The wave movement is so very much reduced with heavy rails, that each rise and fall of the rail is practically vertical, and the distance between supports so small that the rail seats itself squarely upon the tie

A plate having a high center that is cambered or curved, is subject to a more rapid wear than that of a flat-top plate A plate should be designed to give a life equal to that of the treated tie of which it is the wearing surface, and in order that this be accomplished, no part of the plate should be subjected to excessive wear and thus unduly weaken the entire plate, but have the wear on the plate of such uniformity that its maximum life is assured

A Mechanical Mule for Dirt Moving

Several years ago Engineering and Contracting suggested the manufacture of small tractors designed to replace mules and horses for loading and hauling scrapers. It was pointed out that there would always be short-haul excavation jobs where scrapers of one sort or another will be used, and that eventually it would be evident that small tractors could be used in place of animals for scraper work.

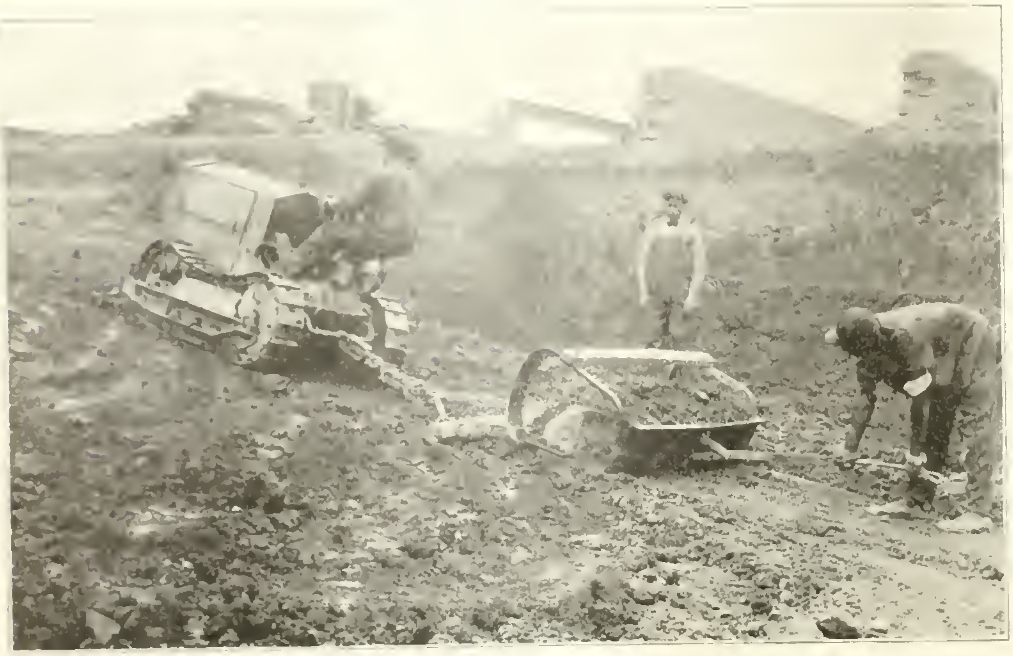


Fig. 1—Tractor Hauling Fresno Scraper on Basement Excavation at Cleveland, O.

The accompanying illustration (Figs. 1 and 2) indicate that our prophecy has been fulfilled, for in Fig. 1 we see a mechanical mule loading a 5-ft. fresno scraper preparatory to hauling it away, and in Fig. 2 we see it loading a four-wheel scraper. Small though it is, this tank-type tractor has more tractive power than three teams, and it travels 50 per cent faster.

The ordinary 5-ft. fresno holds 16 cu. ft. of earth, and requires a four-up team. The tractor is the equivalent of a six-up team and handles twice as much dirt in a day as does a four-up mule team on a fresno.

Contractors in the Eastern and Middle States have been slow to appreciate the economic merits of the fresno scraper. In part this is attributed to the fact that they are not accustomed to use four-up teams. In part it is due to skepticism as to the large loads that can be hauled in a fresno. In Gillette's "Earthwork and Its Cost," the new edition of which has just been published, average outputs are given as 120 cu. yd. of earth (place measure) moved per day with one fresno, where the distance from point of loading to point of dumping is 50 ft.; 100 cu. yd. where the distance is 100 ft.; 75 cu. yd. where the distance is 200 ft.; 60 cu. yd. where the distance is 400 ft.; the average being ½ cu. yd.

We are inclined to think that fresnos for use with a tractor might well be made larger than the standard 5-ft. length, say 6½ ft. The bowl of the standard fresno is 13 in. high and 18 in. wide from cutting edge to back. These dimensions might also be increased. In this way a full cubic yard, place measure, of earth could be hauled by a tractor. Even with the present standard fresno the tractor is an economic success, according to the Crowell-Little Construction Co., of Cleveland, Ohio.

Figure 1 shows the "Cletrac," manufactured by the Cleveland Tractor Co., 19191 Euclid avenue, Cleveland, O., at work on one of the Crowell-Little Construction Co. jobs, in this case, a basement excavation. The same tractor is frequently used in place of a snatch-team for hauling wagons up a steep grade.

Figure 2 shows the "Cletrac" loading a Baker Maney four-wheel scraper at work on a road grading job in Kentucky. G. R. Greeg, manager of the road department of R. B. Tyler Co., of Buffalo, Ky., states that on this job this outfit averages 100 cu. yd. (solid measure) per day on a 500-ft. haul (1,000 ft. round trip), making 16 trip per hour. It will be seen that at this rate the speed was 270 ft. per minute inclusive of the time spent in loading, dumping and delays.

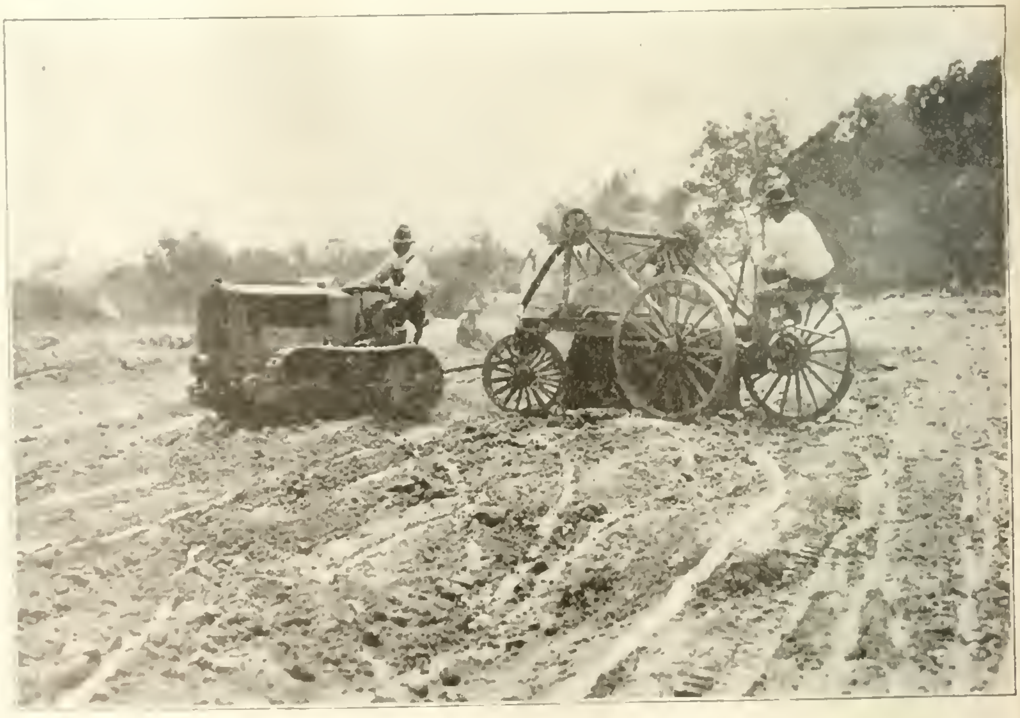


Fig. 2 -Tractor and Baker Maney 4-Wheel Scraper on Road Job at Buffalo, Ky.

Production of Explosives in 1919.—The total production of explosives in the United States in 1919 amounted to 417,634,470 lb., according to the U. S. Bureau of Mines. In 1918 the production was 499,124,660 lb. Of the 1919 total 180,511,050 lb. was black blasting powder, 198,268,588 lb. was high explosives other than permissible and 38,854,832 lb. was permissible explosives. As compared with 1918, there was a reduction of about 26½ per cent in the output of black blasting powder, 15½ per cent in permissible explosives, and nearly 4 per cent in high explosives other than permissibles.

Accounting for Public Utility Replacements*

By L. R. NASH

It is a universally recognized fact that most of the physical property employed in public utility service gradually wears out or ceases to have efficient usefulness because of obsolescence, inadequacy, or other functional causes. There has been much speculation among engineers and accountants as to whether the value or usefulness of public utility elements decreased at a uniform rate, in accordance with a sinking fund curve, or in a manner which permits of mathematical expression. So far as wear and decay are concerned, the rate of deterioration approaches uniformity. It is, however, difficult for an engineering mind to attribute any similar uniformity to the loss in usefulness arising from functional causes. A utility element may render wholly unimpaired service for many years when suddenly a new type of element, or one of greater capacity, may be required for the future, whereupon the service value of the old one drops abruptly to a salvage amount.

It is the experience of those well acquainted with public utility history that comparatively few important property elements wear out in service. Nearly all such elements are abandoned while still in serviceable condition because of insufficient capacity, unsuitability to changing public needs, inefficiency as compared with more modern types of equipment and other similar factors having no direct relation to the age of the superseded elements.

It is sometimes possible to predict with some assurance the time when a particular piece of property will become too small for further service or will fail to satisfy the public demand, but other factors which lead to premature retirement cannot ordinarily be foretold within any useful range of accuracy. In many cases the uncertain factors are more apt to be controlling than the others. It may therefore be stated, without fear of contradiction based upon past experience, that no accurate estimates can be made of the useful life of public utility property with the exception of minor elements recurrently replaced because of wear or decay. Such elements are commonly renewed and charged to Operating Expense, and need have no part in this discussion.

"Depreciation" a Much Misunderstood and Misused Word.—Up to this point the word "depreciation" has not been used herein largely for the reason that it is a very much misused and misunderstood word. Furthermore, when properly used to express the lessening in value or usefulness of a piece of property, it is not as appropriately used in this discussion as the word "replacement" for the reason that accounting should deal as far as possible with definite tangible things. Depreciation, as already pointed out, has no definite measure in the utility field based upon actual experience. A piece of property, such as a street car which is 10 years old, may be said to have depreciated 50 per cent because it has lived one-half of the conventional estimated 20-year useful life of street cars generally. It may however happen, as is happening today, that such cars are retired from service and replaced by cars of the one-man safety type. In the absence of some such factors such a car might not only continue another 10 years in service but might even undergo, from time to time, such extensive repairs that its life might be prolonged almost indefinitely, assuming that its type continued to be serviceable.

It follows that any system of accounting which attempts to set aside periodically a mathematically determined sum of money, intended to equal the cost of a certain element at the time of its retirement, is almost certain to misrepresent the facts of the case and to produce a sum inadequate or excessive, probably widely so. It may sometimes be possible to detect errors in estimates of useful life involved in accounting provisions of this kind and to make correction therefor within the remaining re-estimated useful life of the elements concerned, but such possibilities do not alter the fact that all such accounting procedure reflects not facts but guesses.

The only time when the facts with reference to depreciation are definitely known is when the depreciation is complete, in other words when retirement of the depreciated property is necessary. At that time there should be available a sufficient reserve to write off the element from the utility's property account. In the case of a utility as a whole the replacement of retired elements is a recurrent obligation and it becomes the duty of the utility, both to its investors and to the public, to see that its reserves are always adequate to take care of all such actual replacements. Beyond this a replacement reserve has no practical value.

If a utility undertakes to provide for so-called theoretical depreciation, as required by some prescribed accounting systems, by setting aside monthly an amount estimated to accumulate for each property element or group of similar elements the entire cost by the time retirement occurs, there will, in fact, be accumulated a reserve which will never be wholly used for its intended purpose. Nearly all public utility properties are constantly growing to keep pace with the development of the communities which they serve. Under ordinary conditions the unused portion of a theoretically accumulated replacement reserve might amount to as much as 50 per cent of the entire investment in the property. This unused surplus might be permanently invested or otherwise diverted from its intended purpose without interfering with necessary withdrawals for actual replacement requirements. All this excess reserve is contributed by patrons of the utility in excess of the current costs of service, thereby requiring rates higher than would otherwise be necessary. It is true that there may be some return from the investment of the replacement funds, but this return may be substantially less than the patrons could obtain from investments of their own selection.

For practical purposes, as already stated, the reserves for replacements necessary to meet any actual requirements are very much less than the theoretical reserves, and any greater sum serves no useful purpose other than to reduce the amount of financing otherwise necessary for improvements and extensions.

The Size of Useful Reserves.—It is possible to obtain some approximate idea of the size of useful reserves by a study of specific cases. An examination of appraisals made on numerous public utilities shows that the theoretical accrued depreciation rarely exceeds 20 per cent. On a property without growth this percentage would be much higher, but such a condition in the public utility field is rare. It is inconceivable that any ordinary public utility could spend for replacements in any one year an amount approaching the total accrued depreciation. Some of the elements are practically new and only a comparatively few are close to the end of their usefulness. It would hardly be possible for a mature utility of the ordinary type to spend in any one year as much as 10 per cent of the total investment, or one-half of its total accrued depreciation. This being the case, any reserve in excess of 10 per cent of the total investment would be superfluous and, if the utility by suitable accruals maintained a reserve of the order named, its practical obligations to both investors and the public would be met.

Assuming that such a reserve is suitable, the method of its accumulation is a matter of practical importance in the standardization of accounting systems. Such standardization is now under consideration by various regulatory commissions, and greater uniformity in accounting methods of central stations, gas companies, and other public utilities, approaching that now in effect for electric railways, is much to be desired.

If a rigid system were adopted under which the replacement reserve was always kept at a certain percentage of the investment, the monthly appropriations to the reserve would be approximately equal to the actual charges against the reserve so that the reserve would not accomplish the desirable purpose of avoiding extreme fluctuations in replacement appropriations.

Replacement and Accounting.—Two schools of thought exist with reference to replacement accounting. One asserts that the appropriations for replacements should be definitely fixed upon the basis of the cost and useful life of property elements and distributed with unvarying uniformity regardless of business fluctuations and variations in the balance available for interest and dividends. The other school contends that the requirements for depreciation are not definitely or even approximately determinable in advance so that inflexible appropriations for ultimate replacements are an unwarranted refinement, at least where the total funds available from the operation of the property are variable, as is usually the case.

---

*From the June Stone & Webster Journal.

Certain disbursements from utility revenues are necessary for continued operation free of receiverships. They include operating expenses, taxes, and interest upon indebtedness. It is sometimes claimed that return upon the balance of capitalization represented by stock issues is of such minor importance that the stockholder should be satisfied with whatever balance may remain after operating expenses, taxes, interest and full provision for depreciation have been provided. Here lies the real difference between the two schools above referred to: the one contending for fixed replacement provisions and flexible returns to investor; the other urging fixed returns to investors and flexible replacement provisions. Proponents of the first school fail to recognize that the return sought by investors is in effect a wage. Capital is the product of past labor. Many investors depend upon their income for living expenses, and any curtailment of this income is as serious to them as a reduction in wages or the loss of his job is to a laborer. An investor seeking a profitable use for his money will, among other factors, consider the probability of a regular return, as well as the safety of his principal, and, other things being equal, will select the investment offering the greatest assurance of stability. This is just as logical a procedure as if a laboring man, having two jobs offered him, selected one at a fixed daily wage in preference to another at a possibly higher wage but conditioning the amount of the wage upon the ability of the company to earn it after making all other possible provisions for the protection of the business and its investment.

If capital is entitled to stability of return consistent with definite requirements of the business, and the requirements for replacement reserves are far from definite, as already shown, it follows that the method of accumulating replacement reserves should have such flexibility as will permit stability of return to the investor consistent always with ultimate adequacy of replacement funds. The stability of return thereby provided would definitely tend to reduce the cost of money, would permit financing in times of depression and emergencies when otherwise it would be impossible, and thus tend to develop the utility service and decrease its cost.

The desired flexibility in replacement appropriations might be secured by an accounting program along substantially the following lines:

The accumulated replacement reserve, instead of being a fixed percentage of the investment, might with propriety, because of essential indefiniteness, be set up with maximum and minimum limits from 30 per cent to 50 per cent above and below the normal, respectively. The reserve should always be kept within these two limits. In times of prosperity the upper limit should be approached through liberal appropriations and in times of business depressions, the appropriations could safely be curtailed until the lower limit was approached. Such flexibility in replacement appropriations would tend to stabilize returns to investors and would, as already stated, insure an accumulation of replacement funds sufficient for all practical purposes.

The specific accounting methods under which accruals to the replacement reserve would vary with the prosperity of the business but at all times keep the reserve within suitable limits need not here be set forth, and it would not be a simple matter to lay down wholly definite rules as a substitute for the judgment heretofore commonly exercised in such matters. The suggested general basis of accounting in [illegible] is that after a utility has determined the average amount necessary to maintain in the long run a suitable reserve of the order required, this average rate of accrual should not be curtailed unless the balance available for return to investors after providing for such average accrual, shows a tendency to decrease, in which event the accrual might be curtailed to an extent consistent with the decrease in net revenues, but always within the limits necessary to maintain the minimum reserve. With increasing revenues there should be a corresponding increase in accrual to build up the reserve toward its maximum limit.

It is quite obvious that such a program of replacement accruals differs fundamentally from that prescribed by the Interstate Commerce Commission in its accounting system for interstate electric carriers. The Interstate system has been in effect a comparatively short time during which all carriers have suffered unprecedented reverses until they have reached a point where their credit is most seriously impaired if not destroyed. The number of receiverships has increased beyond any previous records whereas, on the other hand, many industrial enterprises, free from the restrictions surrounding public utilities, have prospered as never before. The accounting requirements of the Interstate Commerce Commission and similar requirements which have been put into effect by State commissions have been a contributing, although by no means a dominant, factor in the present financial condition of public utilities. It is submitted that, in the absence of rigid replacement charges, the utilities so regulated would have been in an appreciably better financial condition and could have functioned more effectively during the war emergencies.

There remains to be considered the question as to whether or not accruals for replacements should be charged to Operating Expenses, as required by Interstate and some State classifications, or by appropriations from surplus, as has been the common practice in the past. The former arrangement has the advantage of reflecting more fully in Operating Expense the cost of operation and upkeep of the property. If, however, flexibility in accruals for replacements is conceded as desirable, there is injected into operating costs an element different in character from those ordinarily so charged, resulting in fluctuations in operating ratios which would be confusing to operating officials who have been in the habit of closely following such ratios and gaging the efficiencies of operation thereby. Operating ratios could, of course, be determined exclusive of replacement accruals for the purposes of routine operating studies.

The general program of flexible replacement accruals within the defined limits of total accumulated reserve would have a very substantial advantage in connection with rate regulation. Regulatory commissions universally concede that a reasonable return upon the value of public utility property is a necessary part of the cost of service, and it will not be disputed that the greater the regularity in this return the lower it may be. If, therefore, this return were made practically constant, as are current operating expenses and taxes, the one remaining element involving flexibility would be the replacement accruals and their accumulation. The accumulated replacement reserve would accordingly be an index of the adequacy of revenues and might properly be used by the commissions as a guide to the need of increases in rates or the possibilities of decreases. In fact, such an arrangement would approach the automatic regulation of fares provided for in the numerous and increasingly popular service-at-cost franchises under which electric railways are operating. There is no reason why regulatory commissions might not substitute a practically automatic program of regulation under the method proposed in place of the present more cumbersome and often long drawn out rate proceedings which frequently fail to furnish relief until long after it is needed. It is believed that the adoption of some such program of regulation, involving flexible replacement accruals, would immediately improve the credit of public utilities subject thereto and permit them to improve and extend their service and reduce their charges.

Progress of Reconstruction in France.—A recent statement by M. Tardieu, in charge of the reconstruction of the devastated region of France, shows the progress that has been made. The following table has been compiled from M. Tardieu's figures:

	Destroyed.	Reconstructed.
Houses (number)	632,944	198,000
Railway lines (miles)	3,439	2,511
Canals (miles)	992	487
Roads (miles)	21,233	4,690
Bridges, etc. (number)	4,785	3,424
Factories, etc. (number)	11,500	3,540

Railway Electrification in France.—A program has been announced for electrification of 6,015 kilometers of the several different French railway systems, with an additional 1,926 kilometers under consideration. A total of 318 kilometers is now under electrical operation on the line of the Midi Co.

Progress of Federated American Engineering Societies

The Joint Conference Committee has issued, under date of July 9, the first bulletin of the Federated American Engineering Societies, the new society resulting from the Organizing Conference in Washington [illegible] and 4. The bulletin outlines the progress that [illegible] made since that meeting. The notes following are [illegible] from the bulletin.

The Technical Club of Dallas, at its meeting of June 22d, made application for membership and at the same time filed its claim as being the first local organization to apply.

At the annual meeting of the American Institute of Chemical Engineers held in Montreal June [illegible] 1920, the question of the Institute becoming a member of the Federated American Engineering Societies was favorably discussed and referred to the council for consideration at its meeting on July 23, at which time definite action will be taken. In the discussion the opinion was expressed that the Institute should be a member of this organization and if its finances would not permit this, that members should be assessed the necessary amount.

"Resolved, That it is the sense of this board [illegible] A. I. Ch. E. should join the Federated American Engineering [illegible] that as there is a small attendance at this meeting [illegible] council will be constituted commencing with the [illegible] the Aug. 1 [illegible] be deferred until the August [illegible] and that a letter be sent the members of the [illegible] board with a request that they give careful consideration [illegible] and be prepared to act at the next meeting."

The report of the delegates to the Washington Organizing Conference was read at the meeting of the Board of Directors of the American Institute of Mining and Metallurgical Engineers on June 27, was favorably discussed and referred to the Finance Committee to devise and report on means of meeting the financial requirements.

The report of the delegates to the Washington Conference representing the American Society of Civil Engineers will be presented at the annual convention of the society at Portland, Ore., Aug. 10-12, 1920.

In the aftermath of the Washington Conference there has been considerable discussion of the new organization and a number of incorrect statements have been made, one of these is that "During the war technical men observed the fact that many engineering problems required the joint action of the technical societies. This requirement was met by the formation of Engineering Council. Now the Organizing Conference proposes new organization." This is not correct, as it has been repeatedly pointed out that the work of The Federated American Engineering Societies will be administered by the American Engineering Council which will succeed the present Engineering Council. The procedure received the approval of Engineering Council at its meeting on Oct. 16, 1919, when it endorsed the "General plan for a national engineering council as outlined by the Joint Conference Committee of the Founder Societies."

It has also been suggested in the technical press that "no specific business is as yet outlined for action by the council"; that "The federated society is so completely nebulous that one cannot commend or condemn it" and it will be some time before the new organization will begin to function. As a matter of fact the Organizing Conference at the closing sessions on June 4 adopted the following resolution:

"Resolved, That it is the sense of this Organizing Conference that the Joint Conference Committee [illegible] when making provisions for putting the constitution of this conference into effect and that Engineering Council be requested to carry on its work until the new organization has been established and by all proper means to further the progress of the new organization. The conference further recommends to the contributing societies that they continue supplying the funds required by Engineering Council until its work is taken over by the new organization."

Engineering Council at its meeting of June 17, 1920, unanimously adopted the following resolutions:

"Voted, That Engineering Council heartily endorses the plan of organization of the Federated American Engineering Societies and the American Engineering Council, adopted by the Organizing Conference of technical societies in Washington, June 3-4, 1920, and authorize its Executive Committee to proffer and perform on the part of council such assistance as may be practicable in completing the work of the Organizing Conference and of [illegible] in establishing the American Engineering Council.

"Voted, That Engineering Council authorizes its Executive Committee to deal with the question of cooperation with the Joint Conference Committee in the transition period, looking to the permanent organization of The Federated American Engineering Societies which may [illegible].

"Voted, That the secretary be instructed to [illegible] of Engineering Council [illegible] of the Organizing Conference in Washington June 3 and 4 [illegible] classes of technical [illegible]."

The action of Engineering Council in accepting the invitation of the Organizing Conference means that the activities of Engineering Council which are those to be undertaken by The Federated American Engineering Societies will be continued without interruption until the American Engineering Council is prepared to take up the work.

The statement that this new organization "is completely nebulous" is refuted by the fact that the Organizing Conference in Washington adopted a complete constitution and by-laws to govern the organization which came into active existence when The American Society of Mechanical Engineers applied for membership immediately following the adoption and at which time assurances were given that the Detroit Engineering Society and the American Institute of Electrical Engineers had taken, or would take, similar action.

To this nucleus must be added the Technical Club of Dallas, so that The Federated American Engineering Societies has come into active existence and the first meeting of its governing body will be held probably in November of this year.

There seems also to be doubt as to the purpose of the new organization as set forth in the constitution:

"The object of this organization shall be to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions."

The organization is to deal with what are commonly known as welfare or non-technical matters. It is not a social organization; it is not an organization of individual members. As its title indicates, it is a federation of societies with whose autonomy and activities it in no way interferes. It does not create a new technical society but it will succeed the present Engineering Council and will be more comprehensive as to scope and membership.

The Federated American Engineering Societies will not in any sense be a competitor of any existing organization. Its success will depend upon the whole-hearted support given by the individual engineers and allied technologists of the country through the respective engineering and allied technical societies with which they are identified. The unanimity of opinion in which there was no dissenting vote, with which the following fundamental resolutions of the Washington Organizing Conference were adopted indicated that the psychological moment had arrived for an organization of this character:

"Resolved, That it is the sense of this Organizing Conference that an organization be created to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions.

"Resolved, That it is the sense of this conference that the proposed organization should be an organization of societies [illegible] and not of individuals."

Method of Climbing Steep Grades on Slippery Track with Railroad Type Shovel. A simple method of getting a railroad type shovel up heavy grades is described as follows in the July Excavating Engineer. A short time ago a contractor in New Jersey was moving a 70-ton shovel up a fairly steep grade. The tracks were slippery and some time had been spent in throwing sand on the track, endeavoring to make the wheels hold but without success. At this point a spectator, who had been watching the proceeding, approached the shovel engineer and bet him that he could show him a method of making the shovel climb. He picked up an old bottle, broke it and laid small pieces of glass on the tracks every few inches for a few feet. The shovel climbed up as if she was on an even track.

General Marshall Appointed Manager of Associated General Contractors

To coordinate the growing varied interests of the Associated General Contractors and to take charge of the development of the broad program adopted at the annual meeting in February the executive board has created the office of general manager in addition to the existing staff and has appointed Brigadier General R. C. Marshall, Jr., former Chief of the Construction Division of the Army, General Manager. General Marshall took office July 1.

The selection of General Marshall marks the beginning of the active campaign to carry through the program which has been developing during the past year of preliminary work.

Photo by Clinedinst, Washington, D. C.

Brig. Gen. R. C. Marshall, Jr.

Besides the direction of the work of the 16 committees, this program includes the development of the publication and information service, the contractor's service corporation, the legislative service, and other service bureaus of the association, and the several members' divisions, including the building contractors' division, the public works contractors' division, the highway contractor's division and the railroad contractors' division, many of which have been organized in charge of different members of the staff during the past year.

The rapid growth of the association from a membership of 7 construction firms representing a few centers to 700 construction firms representing 36 states and 150 cities throughout the country, and the position of leadership which the association has been asked to take on questions of national importance relating to legislation, construction development, labor, materials, transportation methods, trade practices, and the results of the work which has already been done, offer to General Marshall a field of activity commensurate with the ability which he has shown as Chief of the Construction Division of the Army.

It has been in this work that he is most widely known to general contractors. After 20 years of service with the army, beginning in 1898 as captain of volunteers during the Spanish-American War, on Feb. 1[illegible] 1918, he was assigned as officer in charge of the cantonment division; on June 26, 1918, he was commissioned Brigadier General as Chief of the Construction Division of the Army. In his three years in this work General Marshall compressed an experience equal to many years of activity of an able and energetic contractor. He was responsible for all building construction by the War Department of the United States and Insular Possessions, involving an expenditure of more than $800,000,000 and projects including cantonments, barracks, army supply bases, port terminals, storage depots, warehouses, wharves, docks, roads, hospitals, aviation fields, hangars, proving grounds, embarkation camps, engineers' camps, special camps, gunnery schools, balloon schools, emergency housing, lighters, power plants, factories and shops, munition plants, and special plants for the production of nitrates, phosphorus, T. N. T., and other acids, gas and explosives. In connection with this enormous program, he was thrown into close contact with the contractors, the engineers and the labor of the whole country. In addition, his duties kept him constantly in touch with the workings of Congress, of chambers of commerce, and of many other bodies of intelligent and active men.

In recognition of his services, he was awarded the Distinguished Service Medal, the citation reading: "For exceptionally meritorious and conspicuous service in the Construction Division of the Army. His zeal, judgment, and exceptional administrative ability have enabled serious difficulties to be overcome and the construction necessary for a great army to be provided."

Cost of Dredging in Mississippi River

The following data on the operation of Dredges "Fort Gage" and "Fort Chartres" on the Mississippi River are taken from a recent issue of The Military Engineer. The information was furnished by the U. S. District Officer at St. Louis.

These are self-propelling steel-hull suction-dredges, each 97 by 45 by 7½ ft., 4-ft. draft, 815 tons, built in 1908 at a cost of about $177,000 each.

Complement (double crew, two 8-hour shifts), 9 officers, 39 men.

Boilers, six Mississippi River type, horizontal, externally fired, each 30 ft. by 44 in. diameter, with three 10-in. and two 11-in. flues; 3,900 sq. ft., total heating, and 130 sq. ft., total grate surface; 160 lb. steam.

Propelling engines, two Mississippi River, 24 in. by 8 ft.; 800 I. H. P.

Paddle wheel, stern, 26 in. by 21¾ ft. diameter; 16 buckets, 35 in. wide, revolutions per minute 16; speed of boat, 7 miles per hour.

Pumping engines, 2 tandem compound condensing, 16½ in. and 30 in. by 24 in.; 140 to 150 R. P. M., 1,000 I. H. P.

Dredging pump, centrifugal, balanced type, volute lined, diameter of runner, 84 in.; discharge overhead, either side of dredge.

Suction pipe, "dustpan" head 30 ft. wide, 2 suctions, 21 in. diameter; average vacuum, 22 in.

Discharge pipe, 32 in. diameter, 400 ft.; maximum pressure, 5 lbs.

For a number of years these dredges have handled 500,000 to 2,000,000 cu. yd. of river sand and silt per low water season, August to December.

The record monthly output thus far of these dredges is by the "Fort Chartres," in August, 1919, when 344,000 cu. yd. were dredged in 20 working days. The actual dredging time was 203 hours, with 111 hours consumed in handling pipeline and dredge, cleaning suction, etc.; the effective hourly rate thus being 1,100 cu. yd.

The record day's work, however, is by the "Fort Gage" Aug. 6, 1919, when 32,439 cu. yd. were dredged in 12½ hours' actual dredging and pipeline; giving a maximum hourly rate of 2,650 cu. yd. and an effective hourly rate of 2,000 cu. yd.

The unit costs per cubic yard were:

	Field. Ct.	Gross. Ct.
For season 1919—		
Fort Gage (679,000 cu. yd.)	7.9	11.9
Fort Chartres (654,000 cu. yd.)	9.3	13.5
Average	8.6	12.7
For ten years ending Dec. 31, 1919—		
Fort Gage (1,678,000 cu. yd.)	6.6	12.1
Fort Chartres (5,864,000 cu. yd.)	5.6	10.1
Average	6.0	11.0

Principles of Employment Reltions in Construction Industry

As a preliminary to the framing of [illegible] covering the particular needs of the [illegible] industry the Committee on Labor of the Associated General Contractors has submitted a report setting forth [illegible] fundamental principles of industrial employment relations. These principles follow

Employment relations should accord with [illegible] ideals of justice, equality, and individual liberty. [illegible] employment should conform to the essential [illegible] of economic law and should, through intelligent co-operation, based on a recognition of mutuality of interest, make for high productive efficiency. They should [illegible] to realize ideals of individual and social betterment.

The interest of the public, which includes every individual in the community, is paramount. It is composed of interdependent interests whose just balance necessitates that impartial justice be accorded to every individual.

There is a mutuality of interest among employes, employers and investors. Their interests as well as the public interest must be defined and protected and to this end public opinion must be kept informed and enlightened.

The first step toward industrial peace will be a recognition of the interdependence of all elements related to industry and a recognition of their responsibility one to another.

In government and public service employment the orderly administration of government must be assured, and the paramount interest of the public protected.

Briefly stated, Justice to all interests, Co-operation between employer and employe, produces Service to the public.

Principles. I—The Employment Relation.—Every person possesses the right to engage in any lawful business or occupation and to enter, individually or collectively, into any lawful contract of employment either as employer or as employe.

II—The Open Shop. The right of employer and employe to enter into and to determine the conditions of employment relations with each other (without reference to the affiliation or non-affiliation of either with any organization) is an individual right of free contract possessed by each of the parties.

III—Right of Association.—All men possess the equal right to associate voluntarily for the accomplishment of lawful purposes by lawful means. The association of men whether of employers, employes, or others, for collective action or dealing, confers no authority over and must not deny any right of those who do not desire to act or deal with them.

IV—Responsibility of Combinations.—The public welfare, the protection of the individual, and sound employment relations equally require all associations or combinations be subject to the authority of the State. As the public interest is paramount, full publicity of facts of industrial relations is necessary.

V—Obligation to Secure Production.—To develop with due regard for the health, safety and well-being of the individual, the maximum capacity and output required of industry is the common social obligation of all engaged therein.

VI—Wages and Management.—The wage of labor must be drawn from the product of industry and must therefore be earned and measured by its contribution to production. All employes are entitled to complete business information in matters affecting the terms of their employment, and frankness is essential. In order that the worker in his own and the general interest, may develop his full productive capacity, it is the duty of management to assist him to secure regular employment suited to his abilities, to furnish him with incentive and opportunity for self improvement, and to provide proper safeguards for his health and safety.

VII—Hours of Labor. The number of hours in the work day or week in which required maximum output, consistent with the well being of the workers, can be maintained in a given industry should be ascertained by careful study and never should be exceeded except in case of emergency. One day of rest in seven, or its equivalent, should be provided.

VIII—Adjustment of Employment Relations.—Adequate means satisfactory both to the employer and to his employes [illegible] should be provided for mutual discussion and adjustment of employment relations.

IX—Community of Interest. The greatest measure of reward and well-being to both employers and employes and the full social value of their service to the public must be sought in the successful conduct and full development of the industrial establishment in which they are associated. Intelligent and practical co-operation based upon a mutual recognition of this community of interest constitutes the true basis of sound industrial relations.

X—Government Employment. The State is sovereign and cannot tolerate a divided allegiance on the part of its officers and servants. While the rights of government employes, national, state or municipal, to be heard and to secure consideration and just treatment should be amply safeguarded, the community welfare demands that no combination shall be permitted to prevent or impede the operation of government or of any governmental function.

XI—Public Service Employment. In public service activities the public interest and well being must be the paramount and controlling consideration. The power of regulation and protection exercised by the State over the corporation should properly extend to the employes in so far as may be necessary to assure the adequate, continuous and unimpaired operation of public utility service.

The Committee on Labor of the Associated General Contractors consists of the following: Leonard C. Wason, chairman, Aberthaw Construction Co., Boston, Mass.; H. J. Brennan, W. E. Wood Co., Detroit, Mich.; Taylor Field, Ferro Concrete Const. Co., Cincinnati, O.; G. O. Muhlfeld, Stone & Webster, Boston, Mass.; F. W. Smith, Walsh Const. Co., Cleveland, O.; C. P. Waterman, J. H. Grozier Co., Hartford, Ct.

Disposal of Used Explosives Containers

High explosives are generally shipped in stout wooden boxes of convenient size, which are much sought after by miners and others for miscellaneous uses after they are emptied. The management of most mines has no fixed policy for the disposal of used dynamite boxes and will allow any one to carry them away. Many dynamite boxes are nailed up in the mine buildings or underground to serve as shelves and cupboards. Some are used as receptacles for odds and ends, and others are used in taking samples.

Although used explosives containers are so generally put to beneficial service, there is nevertheless an element of danger in their use, states M. C. Lorimer Colburn, Assistant Chief Mining Engineer, U. S. Bureau Mines, in the June Report of Investigations of the Bureau. Dynamite boxes are particularly dangerous. Very often nitroglycerin exudes from the dynamite sticks and is absorbed by the wood of the box. Such boxes are dangerous because they are very explosive. Although a box that has not absorbed nitroglycerin is safe, yet there is always the danger that a person will get a box that is partly saturated.

On account of this danger, all mining companies should use extreme care in giving away used explosives containers. Some one individual who is acquainted with explosives and their peculiarities should act as inspector for every container given away. This job may best be handled by the man in charge of the powder magazine. A box that shows any stain of nitroglycerin should be destroyed by fire. The other boxes that are free from nitroglycerin or dynamite can be used.

The boxes that have been condemned, together with the paper linings of all boxes, should be burned in a place sufficiently removed from all buildings, preferably in a deep hole or behind an earth barricade. The boxes can be ignited by using an electric igniter or a fuse of appropriate length to spit fire into oily waste or excelsior.

Care should also be exercised in the disposal of black blasting powder kegs in which loose powder has been shipped. It is very difficult to get the last few grains and the dust of black powder out of the keg, and serious accidents have occurred by these kegs coming into the possession of children and others unacquainted with black blasting powder. All used black blasting powder kegs should be thoroughly washed with water before giving them away or putting them to use.

Whys and Wherefores of Contract Bonds*

By HARMON V. SWA[illegible]

"A contract bond is a guarantee of the financial standing, moral integrity and ability of a contractor to perform work which he contracts to do."

Back in the days when communities were small and when each man knew the other the necessity for any written guarantee of a man's ability to perform a task which he undertook to perform was almost unknown. As the commercial life of the nation has become more intricate, and as the close, personal touch and association of one man with another has dissolved, it has become more and more vital to safeguard the interests of one undertaking a contract to perform work, as well as the interests of the one for whom the work is to be performed. Out of this situation has grown the necessity for a contract bond—a bond which guarantees the faithful performance of work which one organization undertakes to perform for another individual or organization.

In former times, the contractor furnished a personal bond, or satisfactory security that he would complete the work in a specified time and according to the stipulation set forth in the specifications which accompanied the contract. Today, however, experience has proved that rapidly changing conditions in the financial status of the contractor has made it difficult, if not impossible, to collect damages in the event of non-fulfillment of the contract. More dependable security, therefore, for the performance of a contract was found not only desirable, but necessary.

These conditions resulted in the organization of modern bonding and surety companies, formed under the banking and insurance laws, designed to supplant the personal bond and to furnish bonds for contractors to be given as security or guarantee that contracts would be performed in strict accordance with the terms set forth in the contract. These bonds have become known as "Corporate Surety Bonds" or as they are commonly known, "Corporate Contract Bonds."

Why the Surety Company Ought to Know. The bonding or surety companies issuing these bonds are required by the banking and insurance laws to carry and maintain their surplus and capital unimpaired. They must carry a liquid reserve fund sufficient to pay such losses as may be expected by reason of the default of the contractors, whom they have bonded. By issuing a contract bond on a contractor, the surety company, therefore, assumes a great responsibility and must satisfy themselves that the contractor is fully reliable and able to execute the contract he has undertaken.

Because of the fact, therefore, that the surety company is the guarantor of the faithful performance of the work covered by the contract, it is necessary before they assume the liability which is theirs, that they have full and complete information as to the ability of the contractor to perform the work he undertakes. Consequently, the questions which the company may ask of the contractor are neither foolish, nor inquisitive, but are based on sound business principles, not on any desire to idly inquire into the contractor's personal [illegible] or to unduly bare the secrets of his bank balance.

The wise contractor hides nothing from his underwriters, but willingly bares his records and his bank account and welcomes the closest scrutiny. In fact, the contractor who obtains a contract bond many consider that he has received an [illegible] mark of recognition as to his ability to perform the contract which he has undertaken.

What the Surety Company Ought to Know. The line of [illegible] pursued by a surety company before it will undertake to underwrite a contractor should reveal the following:

Is the contractor a proper man for whom the surety company may pledge their credit, with reasonable safety, in the form of a bond, to those with whom the contractor makes agreements?

How has this contractor conducted his business in the past? Is the contractor thoroughly conscientious and eager to perform all the work called for in his contract?

Has the contractor paid for material on note or invoice basis? Does the contractor meet his payments promptly?

Is he making wise use of his capital and borrowing capacity, or is he overreaching his capital?

What type of subcontractors does he employ and in what regard do the subcontractors hold him? (This will reveal the likelihood cf trouble between the contractor and his subcontractors.)

How is the contractor regarded by architects, engineers and owners for whom he has previously done work? (This offers guidance from both a technical and business standpoint and develops information as to the trustworthiness of the contractor and has ability to deliver work rather than excuses, contentions, etc.)

Is the contractor honest, reliable and dependable?

What has been the relation of the contractor with his banks on previous contracts; how were obligations met; what line of credit was extended by the banks; what was the attitude of the banks as to further credit, as to the contractor's financial responsibility, as to his bank balance; what stocks, bonds and other securities does he possess and in what company?

What mortgages has the contractor given and on what property; are these sound mortgages?

What real estate, if any, does the contractor own? Is it farm or city property, improved or not improved; income producing or otherwise? Is his property free and clear of encumbrances and in whose name is it carried, his own or his wife's?

In order that the surety company may have the information to satisfy itself as to whether or not the contractor is properly equipped to undertake the work in mind and prosecute it to a conclusion, the company should know:

Is the contractor's equipment suitable for the contract to be undertaken? Complete information as to plant and equipment needed.

What quantity of material has the contractor on hand suitable for the contract in question?

What contracts has he under way and what is their condition as regards completion?

What payments are due and payable on work already undertaken, together with approximate due dates on future payments?

Are any of the payments due assigned or held up in any way by litigation, liens, or for any other cause?

What are the contractor's obligations on account of loans from banks and any other source?

What is the amount of accounts payable for materials and due subcontractors for work under way or completed?

For what other obligation, such as notes, surety for others, etc., is the contractor liable? Has the contractor ever taken advantage of the bankruptcy laws and if so, what settlement was made with his creditors?

Since the surety company is asked to assume financial responsibility in common with the contractor the questions seem reasonable. Certainly the surety company should not obligate themselves without a full understanding of the risks they assume.

The same line of questioning is pursued if the contractor is a corporation or firm and at the same time assurance is required that every individual member of the corporation will back his company to the full limit of his personal responsibility.

The information obtained by the surety company is carefully weighed in order that a conservative net worth of the contractor may be arrived at, the balance of assets over liabilities, responsible, real and based on sound assets, in which slow assets or doubtful ones such as equity in heavily encumbered property—are either disregarded or heavily discounted; apparent worth based on bookkeeping trial balances, until carefully analyzed and verified, carry little weight. The actual net worth of the contractor is derived from real available assets, not from paper assets or slow assets with doubtful value.

Satisfied as to the contractor's financial responsibility, the board of underwriters now determines whether or not the contract on which the bond is sought is similar to work previously handled by the contractor, or whether it is work, wholly or in part strange to him. The surety company will more quickly issue a substantial bond to a contractor doing familiar work in which he has proved his ability, than on work with which he is unfamiliar and where there is a question as to his ability to handle it successfully.

Advantages of a Contract Bond.—The contractor who objects to furnishing a bond places himself at once, unwittingly, in the same class with the man who accepts goods at [illegible] ult inquiry as to his credit and [illegible] But [illegible] financial responsibility never [illegible] careful scrutiny. The contractor who fails to [illegible] himself a grave injustice. On the other hand [illegible] contract bond is evi[illegible] to the world that the contractor has passed the acid [illegible] that he is thoroughly reliable [illegible] as a contractor, and that he has the financial ability [illegible] up his reputation.

---

*From the June Bulletin of the Associated General Contractors.

A contract bond in addition to [illegible] the contractor [illegible] the owner as well in that the [illegible] to make [illegible] at stated intervals in accordance with the terms of the contract or else runs the risk of [illegible] the bond.

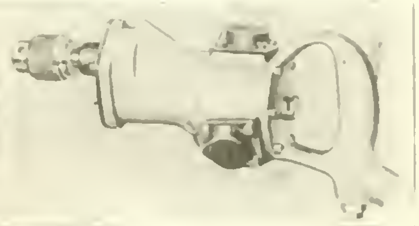
It will be seen from the foregoing [illegible] that every contractor cannot get a contract [illegible] the [illegible] of a contract bond, which [illegible] instrument from every standpoint cannot [illegible] tigations must be made and decisions [illegible] reached. Consequently the wise contractor [illegible] his requirements sufficiently in advance so that when the time comes when he needs his bond he will have his accounts in perfect order and will be ready [illegible] books with pride because the impression so gained [illegible] to his good will.

New Sizes of Small Pneumatic Tools

Several new sizes of small portable pneumatic [illegible] recently been added to the line of "Little David" [illegible] tools manufactured by the Ingersoll-Rand Co., 11 B[illegible] New York. The new tools include a small size of close quarter drill to be known as No. 8, a small high speed pneumatic grinder in two types, No. 601 and No. 602, and a lightweight drill furnished in two styles, No. 6 and No. 600.

No. 8 Close Quarter Drill.

No. 601 Pneumatic Grinder.



No. 6 Light Weight Drill.

The No. 8 close quarter drill is a machine for use in certain classes of work, as close to a wall or corner. This new machine has a fairly high speed, running at 250 r. p. m. without load, but will handle drilling, reaming or tapping up to 1¼-in. diameter. The tool is throughout a special design for close quarter work and has several unique features. The spindle which turns the drill, reamer or tap, is operated by three rocking levers connected directly to the pistons through connecting rods. The motor is of the three-cylinder type with pistons acting at right angles to the levers. A very steady continuous movement of the spindle is obtained as one ratchet pawl is always in contact with a tooth of the spindle. The construction is very simple and sturdy, with least number of parts.

The No. 601 and No. 602 grinders are lightweight high-speed tools running with a free speed of 4200 r. p. m. and suitable for grinding, buffing or polishing work of a varied nature. Both machines have the same type motor, but are equipped with different throttle and handle, the No. 601 having the [illegible] type of inside trigger handle, while the No. 602 is fitted with the rolling type of throttle handle. A special feature of these tools is the three-cylinder motor—(very different from that of the No. 8 drill, described above)—which runs constantly in a bath of oil, insuring lubrication of all the parts.

The No. 6 and No. 600 drills will handle twist drills from the smallest size up to ⅜-in. diameter. The free speed at 90 lbs. air pressure is about 2000 r. p. m. The two machines differ essentially in the handle construction, the motors being the same. The No. 6 has the pistol grip type of handle, while No. 600 is furnished with breast plate and rolling throttle handle. Aluminum, reinforced with steel bushings, is used wherever possible and results in a very lightweight machine, the No. 6 weighing only 9 lbs. The motor is a 3-cylinder type somewhat similar to that used in [illegible] The cylinders [illegible] renewable and [illegible] interchangeable. A [illegible] throttle control has been obtained.

How to Determine "Critical Point" in Tempering Drill Steel

In the operation of tempering or heat treating all straight carbon steel should be quenched when heated to the critical point. A skilled smith may determine the point by experiment and gauge the heat by taking note of the color, but this method is unreliable unless a check is provided, for oftentimes the eye gets off color, being influenced by the degree of surrounding light and the physical condition of the operator. In the absence of a pyrometer equipment the following method is suggested by Mr. George H. Gilman in an article in "Granite, Marble & Bronze" as a check.

A small pocket compass, preferably with a jeweled needle and stop which may be procured in almost any jewelry or hardware store at a nominal cost, and a pair of brass or other non-magnetic tongs are the only essentials. This compass should be set upon a wooden block in close proximity to the forge and in such a position that the natural swing of the test piece back and forth when being tested will be in a plane at right angles to the needle. In other words, the test piece being hardened should be swung east and west, using brass tongs. By passing the test piece forward and backward close to the compass, the magnetism of the metal will cause the needle to be deflected first one way, then the other and will continue to deflect the needle until the proper heat for quenching has been obtained. The right heat is reached when the material loses its magnetism. It does not follow, if the needle remains stationary the first time you test, that the heat is right, because after the material has reached a certain degree of heat the magnetism leaves the steel, so there is no influence on the needle and it may be too hot. Different grades of drill steel having different carbon content require different degrees of heat. The magnetism leaves the steel at that degree of heat corresponding to the carbon content in the steel, and in every case this is the proper heat for quenching.

A. A. E. and the Federated Societies*

Increased prestige and opportunity for service came to A. A. E. out of the conference in Washington June 3 and 4 called by the Joint Conference Committee of the national technical societies.

Little if any occupation of the field occupied by A. A. E. is contemplated by the federation. On the one hand is the federation composed of societies and created for the public good; on the other hand is the democratic organization of engineers devoted primarily to helping the individual engineer to get on in life. A. A. E. was apparently recognized as the servant of the profession in the welfare field. There can therefore be nothing on the part of A. A. E. but cordial good wishes to the federation.

Now that the field of human welfare is left to A. A. E. there is every reason for every member of the national technical societies to join us and help solve our common problems. Important as is the public good, the welfare problems compass not less but more than 80 per cent of the circle of human life. If the spirit of the Washington conference is interpreted right, its advocates should look with favor on the continued growth of A. A. E. and ultimately lend every assistance to its embracing all of the engineers of the country. We feel that the effectiveness of the federation would be greater had the conference adopted the offer of A. A. E. to make use of the central office of the Association instead of starting a new and additional operating headquarters. We hold that no federation of societies can approach the virility of this democratic organization, deriving its strength from individual members and having a definite connection from every member to national headquarters. However, A. A. E. is no "dog in the manger" and is willing to see the new plan tried.

---

*Editorial in the July Professional Engineer, the official publication of the American Association of Engineers.

Straightening Creek Channel with Dynamite

By CLYDE H. ALBRECHT.

Last December two bridges were in danger of being undermined at one end by the overflow of a crooked stream which had become clogged at one of the bends. As the ground was frozen to a depth of 2 ft., speed in remedying the condition, didn't seem feasible. Five 18-in. stumps in the right of way also did not serve to lessen the difficulty.

It was decided to use dynamite, but as the soil was dry sand and it was necessary to have a ditch 8 ft. deep, it was bound to be an expensive operation, because dynamite doesn't work well in dry sand and 6 ft. is about the limit of depth for economical blasting; then, too, the 2 ft. of frozen surface added to the amount of dynamite necessary to use.

As the top width was to be 14 ft., I put down two rows of bore holes, 3 ft. apart, using a "frost point" to get through the frozen crust. The holes were about 21 in. apart in the rows, and 5¼ ft. deep. Three pounds of dynamite were loaded in each hole—1 lb. of 60 per cent straight N. G. and 2 lb. of 40 per cent ammonia. Where the stumps were encountered, extra charges were placed directly under them. Electric blasting caps were used in every hole and a blasting machine used for firing.

This original shot gave us the desired 14-ft. top width and about 6 ft. depth. To take out the additional 2 ft. required, putting down another row of holes along the center of the bottom of the cut made by the first shot. These holes were 2 ft. deep and were loaded with one cartridge of 60 per cent straight. These charges were also fired with electric blasting caps.

The job consumed 54 hours' time, for which the labor charge was $39. The explosives cost $114. Per lineal foot, the cost figured $8.50, which seems high unless the unusually difficult conditions are considered.

Safety Net Under Concrete Distributing Chute.—To catch large stones jumping out of chutes used for distributing concrete and so avert injury to men below, a safety net has been used successfully on a large construction job under way at one of the plants of E. I. du Pont de Nemours & Co. At 4-ft. intervals a 3¾ in. angle iron is fastened across the chute, extending outward a foot on each side. Through holes at the ends of each angle iron a wire is run parallel with the chute and 1-ft. distant on each side. A chicken wire screen, ¾-in. mesh, is fastened to these wires and thus suspended below the chute.

News Letter

ST. LOUIS ITEMS.

By A. B. KOENIG

H. J. Larkin will be in charge of camp and payrolls for the J. W. McMurray Contracting Co. on their job at Oakwood, Mich.

Land & Simpson, Ballinger Bldg., St. Joe, Mo., want to buy or lease a caterpillar or walking dredge.

John A. Buchanan, who some years ago was with the Pittsburgh Tubular Steel Whiffle Tree Co., is now with the Sales Division Car and Mine Accessories of the U. S. Chain & Forging Co., Pittsburgh, Pa. [illegible] is visiting all his western friends in the contracting business.

M. C. Carter [illegible] on a cut off for the Burlington R. R. near Aurora, Ill.

F. Y. Sutherland [illegible] finished the bridge and pile driver work on the Ft. Smith [illegible] Rock Island R. R., and has his outfit [illegible] on work immediately. 217 Breman Ave., St. Louis, Mo., will catch him.

The C. P. Carey Co. of Cleveland, O., have opened a branch office in Room [illegible] Railway Exchange Bldg., St. Louis, with P. J. Watson, Jr., in charge.

L. J. Smith, president of the L. J. Smith Construction Co., was taken very ill here the other day, but from last accounts has improved a little.

J. W. McMurray of the J. W. McMurray Contracting Co. passed through St. Louis on his way to Kansas City from Oakwood, Mich. Mack says they are getting a good start on their Wabash bridge over the Rouge river at that point.

A. L. Cook, Ottawa, Kan., was the successful bidder on a number of new roads being constructed by the state of Kansas. Cook can also use a lot of teams on force account work on the Cotton Belt R. R.

Contractors when in want of work or labor for their outfits write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo.; 503 Delaware St., Kansas City, Mo., or 1020 Douglas St., Omaha, Neb.

P. J. Murphy, Moberly, Mo., can use a few small team outfits on bank widening work on the Wabash R. R. in Missouri.

R. T. Amis, Lebanan, Mo., has 150,000 yards of steam-shovel work on the Frisco R. R. to let at that place. This is all classified material, suitable for a four-yard outfit.

J. C. Mulvill, the well known contractor of Alton, Ill., is being urged by democratic friends to make the race for representative to the State Legislature from his district. Charley is popular, and as there is one democrat to be elected anyway, most people of all parties in this end of the district would be glad to see him fill the position.

Edwin D. Smith, chief engineer of the United Rys. for 15 years, resigned, effective Sept. 1, when he will become superintendent of power and maintenance for the National Cash Register Co. at Dayton, O. Smith is a member of the City Plan Commission and is a former president of the Engineers' Club of St. Louis.

August H. Heman, 64 years old, of 6361 Washington avenue, mayor of University City and president of the Heman Construction Co., died at his home on July 3rd after an illness of one day, from heart trouble. He was at his office in the Title Guaranty building the day previous. Heman was serving his fourth 2-year term as Mayor. His firm constructed several of the buildings at the Chain of Rocks waterworks station, and built the cascades, the chief scenic feature of the world's fair of 1904 on Art Hill in Forest aPrk. The firm did much street and sewer building. Heman was a native of St. Louis and did his first contracting work for the city in 1875. He was married in 1888 to Miss Leota Lightner, daughter of a steamboat captain. Their son, Alonzo, died four years ago. Mrs. Heman, a brother, J. C. Heman, and a married sister survive him. A. 1

Personals

D. Rounsville has been appointed assistant chief engineer of the Chicago & Northwestern Ry.

Clarence T. Garrett, for 28 years assistant engineer of the Bureau of Sewerage of Philadelphia, Pa., has resigned owing to ill health.

Martin E. Kelly has resigned as city engineer of Anaconda, Mont., to accept a position as assistant engineer in Federal government improvements on the Virgin Islands.

W. L. Thompson has been reappointed chief engineer of the Mississippi Levee Commission, Vicksburg, Miss., and Robert Somerville has been reappointed assistant chief engineer.

W. E. Holland has resigned from the Central Foundry Co. and will in future be engaged in the waterworks business under the firm name of Cole & Holland, 628 J. M. S. Bldg., South Bend, Ind.

Brig. General Frank T. Hines, chief of the Bureau of Transportation in the War Department, has been designated by Secretary Baker to head the Inland and Coastwise Waterways Service, established under the new Transportation act. The service is to assist in the development of inland water routes and lines.

Kastenhuber & Anderson, Civil Engineers and Surveyors of Easton, Md., announce the withdrawal of John Anderson from that firm. Edwin G. Kastenhuber, Jr., will continue business under the present firm name of Kastenhuber & Anderson. Mr. Anderson has taken up work as an instructor at The Citadel, Charleston, S. C.

Howard N. Eavenson has resigned his position as chief engineer of United States Coal & Coke Co., with mines at Gary, West Virginia, and Lynch, Kentucky, and has opened an office as mining engineer at 230 Fifth Ave., Pittsburgh, Pa., where he will conduct a general mining engineering business.

Captain Edward F. Dickins, for over 50 years in the Coast and Geodetic Survey, has resigned. He entered the service 51 years ago, being for some time engaged in triangulation and topography along the California coast. Then for several years he was captain of the Coast and Geodetic Survey steamer Gedney, surveying and charting Alaskan waters. For three years Captain Dickins was director of the coast survey at Manila and for seven years inspector of the New York Coast and Geodetic Survey district. During 1915 he returned to San Francisco from New York and since that time has been an inspector in the San Francisco office.

Obituaries

Herbert W. Hatton, a civil engineer of Wilmington, Del., died July 13, aged 38.

Ethan C. Churchill, assistant division engineer of the Lehigh Valley R. R., died suddenly July 9 of heart disease. He was 62 years old.

Lewis M. Layne, Vice President of the Layne & Bowler Co., Memphis, Tenn., died June 27.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Hydro Dumping Equipment for Trucks.—The Heil Co., Milwaukee, Wis., 12-page circular illustrating and describing the various models of truck bodies, hydro hoists and truck tanks manufactured by this company.

Oil Well Chains.—The Jeffrey Manufacturing Co., Columbus, O., 8-page bulletin illustrating and describing the important features embodied in the design and construction of the oil well chains. Also shows interesting views of the chains in actual service on drilling rigs.

Portable Conveyors.—Portable Machinery Co., Passaic, N. J., 24-page catalog showing the various uses of the scoop conveyor and other portable conveyors manufactured by this company.

Tractors.—Holt Manufacturing Co., Peoria, Ill., 32-page booklet illustrating the various uses to which the "caterpillar" tractor has been put in industry and agriculture.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor*   LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: [illegible] Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: [illegible] 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4 00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1 00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of [illegible] Associated Business Papers, Inc.

Volume LIV   CHICAGO, ILL., JULY 28, 1920.   Number 4.

Are High Wages the Only Justification for Labor-Saving Machinery?

It has frequently been said that in such countries as China where wages are very low, the use of labor-saving machinery may not be justified on economic grounds. The editor of one of our American engineering journals has recently used the same argument in reference to pre-war England. He says:

> We are sometimes told that the British contractor [illegible] methods and is not open to conviction regarding the labor-saving devices developed in the United States. What I have learned can be summed up in this sentence: Had the British contractor been faced ten or fifteen years ago with the high price of labor that then prevailed in the United States (and that now prevails in Great Britain) he would have been using [illegible] machinery as the American contractor is using today.
>
> In other words, the British contractor is wide awake. He knows how to figure a job closely. He knows that labor-saving machinery, competently operated, will reduce [illegible] when wages are high. When wages are high—that is the key of the situation, the reason for the difference between British and American construction methods. Before the war good construction labor could be secured in Great Britain for [illegible] (about fourteen cents of our money, under the pre-war rate of exchange) and with labor—good labor—at that price we must admit that the use of expensive labor-saving machinery would not be justified. Today conditions are quite different. Wages have more than trebled and the efficiency is only [illegible] per cent of what it was. Pick and shovel men now get two shillings [illegible] about fifty cents an hour. The British contractor is therefore rapidly turning to labor-saving construction machinery.
>
> It is apparent, too, that the wide-awake British contractor is very favorably impressed with the type of construction machinery we make in the States. Such is the demand that an agent for American construction machinery assured me that if he had ten times the amount he is now receiving from the States he could dispose of it at once.

Our contemporary, it seems to us, has fallen into the common error of supposing that high wages are the primary cause of a more extensive use of machinery. The fact is just the contrary. The extensive use of machinery is the main cause of high wages when "high" means large purchasing power. Wages in England are now several fold as "high" as before the war, but the "height" is measured in money and not in the things that money buys. Measured in "goods" or commodities, English wages are probably lower than before the war; certainly they are not appreciably higher. In short, there are two kinds of "height" in which wages may be measured, (1) "height" in money and (2) "height," in goods. The English worker's wage has increased in the former kind of height, but not in the latter kind.

Increase in mere money "height" of wages has no effect one way or the other, on the economy of using machinery, but it does have a psychological effect upon the employer. Employers are accustomed to think in terms of value that existed prior to the war, and if money wages have doubled the average employer is inclined to resent the increase as being an unfair imposition. Hence he bestirs himself to "beat the game" by using machinery.

The truth of the matter is that it would have been just as economic to use American construction machinery in England in 1913 as in 1920, but English employers were either not so given to using their wits or were more fearful of labor strikes.

If money wages in England have risen a greater percentage than the price of machinery has risen, then it would be correct to say that it is more economic to use machinery now than prior to the war, but this condition is not shown to be a fact. If money wages and machinery prices have risen an equal percentage, then there is not the slightest gain in economy through using machinery now as compared with the pre-war period. Put differently, English employers were just as much justified in using machinery five years ago as today, only their wits were duller then than they now are.

Some of the History of the Slide Rule

Three hundred years ago Edmund Gunter invented a logarithmic scale for mechanically multiplying numbers. He used a compass with which to perform the mechanical addition of the logarithms on the scale. It was not till 1672, or 52 years later, that Edmund Wingate improved this device by inventing the [illegible]. How many engineers know anything about these two men? Gunter's name is associated with the [illegible] chain of 100 links that he invented for measurement purposes, but he is seldom thought of in connection with the slide rule.

The Encyclopedia Britannica devotes about a quarter of a page to Gunter's biography, but no space at all to Edmund Wingate. However, the latter's invention is described, and his name mentioned under "Calculating Machines." The inventions of Gunter and Wingate were made possible by the invention of logarithms. This great invention by John Napier was first made public in 1614 after 20 years of work upon it. Prof. Henry Briggs, speaking of Napier's work in 1615, wrote:

"Napier, lord of Markinston, hath set my head and hands a work with his new and admirable logarithms. I hope to see him this summer, if it please God, for I never saw book which pleased me better, or made me more wonder."

It was Briggs who suggested to Napier the advantages that would result from the use of 10 as a base, and it was he who first published a table of decimal or common logs. Edmund Gunter was Briggs's colleague as professor of astronomy and was not a civil engineer as is commonly believed.

It is instructive to note that it required the work of four inventive minds to develop the slide rule. It would be equally instructive to study the successive developments in the slide rule that have occurred from time to time. Only [illegible] years ago Wellington voiced his regret that he had not had one of Edwin Thatcher's cylindrical slide rules when he was engaged in the calculations in his "Economic Theory of Railway Location." Mr. Thatcher is an American civil engineer now 80 years old. He is also the inventor of several types of trusses and of the concrete reinforcing bar that bears his name.

One can not read the history of the slide rule without concluding that there may remain many new forms that it may yet be given by inventors. The thought arises that engineering students should be required to read such histories as this, for there is more inspiration in studying the evolution of an idea than there is in studying the final result.

Don't Blame It All on the I. C. C. and the F. R. B.

In its issue of July 8 the Manufacturers' Record has a long symposium, entitled "The Breakdown of Building Operations by the Interstate Commerce Commission and the Federal Reserve Board," from which we quote:

> This country is short about 2,000,000 dwellings. Millions have found it to be well-nigh impossible to secure a dwelling or an apartment, and the situation steadily grows more tense.
>
> Despite this fact, the Federal Reserve Board advises the curtailment of house-building operations, and building associations which have been active for years in co-operating with people in building and the buying of homes are now by action of the Federal Reserve Board unable to secure from banks the money with which to help to create the dwellings so badly needed. Verily, it would seem that this is the very limit of human incompetence and narrowness of vision.
>
> Next to the Federal Reserve Board in adopting such a plan and [illegible] for evil is the work of the Interstate Commerce Commission, which has practically placed an embargo upon the handling of building materials of all kinds and thus forced the cessation of building operations.
>
> No man dare undertake the erection of dwellings or buildings of any kind with the sword of the Federal Reserve Board and the equally dangerous sword of the Interstate Commerce Commission hanging over his head. If the situation were not so tragic in the extreme and one of dangerous moment to the existence of the country, it would be laughable that men, supposed to have a fair degree of intelligence, should today seek to curtail the building of dwellings and apartments when there is such a lack as to make the housing problem one of the most serious questions that the nation must solve.

While we do not agree with the Manufacturers' Record in its statement that the Interstate Commerce Commission and the Federal Reserve Board are a grave menace to economic progress, it is evident that the acts of each of these governmental bodies have caused a slackening of construction work that is very serious. On the other hand, what have engineering, architectural and construction associations and societies done to prevent the conditions that now exist? Have they not, for the most part, waited until the construction industry was crippled before they began even to complain of the lack of wisdom of these two governmental agencies? When did any body of engineers, architects or contractors even pass a resolution condemning the narrow policy of the Interstate Commerce Commission that for ten years has been killing the credit of the railways? When did any of them go before the Federal Reserve Board to secure the aid of that Board in financing construction work?

One of our grand economic errors consists in practically ignoring the policies of governmental bodies until these policies have resulted in ills that could easily have been foreseen by professional and business men. Then we try to excuse the effects of our own negligence by damning the Government officials whom we should have tried to guide. We know that such officials are rarely as well informed as we are respecting our business, yet we allow them to develop policies that will affect our business, and we remain inattentive to their theories at the very time we should be "all eyes and ears." Only after we are hurt do we ordinarily arouse ourselves, and even then our activity is apt to be confined to protests rather than to constructive programs.

Teaching Economics to Engineers

In discussing the report of the Committee on Economics of the Society for the Protection of Engineering Education, William M. Duffus, associate professor of economics of the University of Kansas, expressed his regret that the committee has recommended only three hours a week for one semester. This is equivalent to about 60 hours class work in a four-year engineering course. We are in accord with Prof. Duffus when he says that doubling the number of hours would more than double the value of the course in economics.

As we have said before, the committee's conception of economics is a narrow one, since it regards economics as consisting only of political economics. Moreover, the committee seems to have been unduly influenced by the vagueness and doubtful character of much that is taught by political economists. For example the committee says:

> Economics deals largely with general averages, and the student with a smattering of economic factors may talk glibly of glittering generalities, about "movements," "trends," "tendencies," "waves," "tides," "streams," "currents," "drifts," etc., and yet may mistake a patch on a man's trousers for a "wave of economy." Therefore, accuracy of observation, clear and direct thinking, and discerning judgment in analysis should be striven for in instruction, with an effort to separate the relevant from the irrelevant, in considering any particular question, rather than to arrive at certain preconceived conclusions of more or less dogmatic character, which may after all, be more dependent upon the professor's experience and training than upon an unbiased survey of facts. Most questions of political and social organization, after being brought to the attention of the class and having their significance indicated, instead of being "settled" by the teacher, would best be left to the further reading and observation of the student with the mental road left open for each to arrive at his own final conclusions.

We agree with the committee that existing treatises on political economics consist largely of "glittering generalities," many of which are of doubtful accuracy. But does it follow, therefore, that engineering students should be given only 60 hours of class work in economics? Because so much of the text of existing books on political economics is vague or doubtful, should engineers be led to think that political economics is and must remain largely a science of "tendencies" and "drifts"? Is it not preferable to take an entirely different attitude toward this science?

Should we not inspire engineering students with the thought that it devolves upon engineers to create a real science of political economics, even as they have made a real science of engineering economics?

Not all of the existing science of political economy is fairly to be classed as a science of [illegible]. But even if it were, political economy would be a very useful study for engineers. The old-fashioned engineering teaching, which still is dominant in most of our [illegible] is such as to make engineers sniff at conclusions that are not mathematically demonstrable. There is sore need of training in a science many of whose generalizations hold good only as to "majorities" and not necessarily as to the individual. Such, in large measure, is political economy, [illegible] also is psychology. Successful business men have [illegible] been quoted as saying that they owe their success [illegible] been able to forecast results correctly at least [illegible] of the time. For many purposes, to be able to predict [illegible] in more than half the cases will suffice to [illegible] success, but excessive training in the exact [illegible] to obscure this important generalization, and [illegible] to develop a mind that is not supremely well [illegible].

Of course the goal of all science is [illegible] knowledge of all the classes of energy and [illegible] inability to attain ideal or perfect knowledge [illegible] valid reason for poohpoohing partial knowledge [illegible] us that the committee has come dangerously [illegible] poohpoohing political economy because of its imperfection. Indeed, the absurdly small allotment of class time to this great science is itself little less than a plain [illegible] the committee regards it as being an unessential part of the educated man's equipment.

Efficiency of Labor in Building Trades

To the Editor: I am enclosing a statement showing efficiency of labor and resulting cost therefrom in the building trades as they existed in this district at the close of 191[illegible]. If the same conditions exist in the country as a whole, your deductions as to cost changes, in your article on price changes in your April 7 issue, for the future in building construction are not made on a firm basis, since a decrease in building construction would change the labor situation materially, introducing discipline, which is now entirely lost, and with it increased production.

JOHN B. MILES

Norfolk, Va.

EFFICIENCY OF LABOR IN TEN BUILDING TRADES, NORFOLK, VA., JAN. 15, 1920

A	B	C	D	E	F	G	H	I	J
Trade	1914 Rate per day.	1919 Rate per day.	Per cent Increase.	1914. Production	1919. Production	Per cent of Efficiency	Relative cost Production	1914 Cost per Unit	1919 Cost per Unit
								Hanging doors, each	
Carpenters	$3.50	$7.00	100	9 doors 11 openings	5 doors 6 openings	55	364	$0.388	$1.40
								Brick per Thousand	
Brick layers	5.00	9.00	80	1900 per day	800 per day	42	428	$2.63	$11.25
								Plastering per sq. yd.	
Plasterers	5.00	8.00	60	150 sq. yds day	75 sq. yd. day	50	320	$0.033⅓	$0.106
								Painting per 100 sq. yds.	
Painters	3.00	7.00	133⅓	1800 sq. ft. day	900 sq. ft. day	50	466	$0.16⅔	$0.77 7/9
Common labor	1.60	4.00	150			Estimated 60	417		
Average	$3.62	$7.00	93			51	396		

*Cost per unit. Columns I and J are not total cost since they do not carry charges for helpers, overhead expense, etc.
Data obtained from reputable contractors and assumed to be approximately correct.
Eight-hour day.

Use of Undressed Lumber in Building Construction

To the Editor: Reference is made to the article in the June 23d issue of Engineering-Contracting entitled "Standard Lengths, Sizes and Quality of Lumber as Related to Economic Designs." In the discussion under the above head it is suggested that the use of undressed lumber might well receive some attention. In some sections, it is almost impossible to secure rough lumber, the mills preferring to run all of their output through the planer to secure uniformity of width and thickness. This is desirable in certain portions of a structure, but results in an unnecessary waste or sacrifice of strength in such timber as exposed floor joists.

To illustrate this point: The writer had charge of the construction of a number of "Divisional Store Houses" for the use of the army in 1917. The floor plans called for 3x12 joists with spans of 12 ft. The timbers as actually furnished were a scant 2⅞ in. thick by 11½ in. deep. If they had been furnished in the rough, following usual mill practice for rough timber, they would have averaged in excess of the nominal dimensions specified. While there is a slight economy in labor in using joists that have been dressed to a [illegible] depth [illegible] ing these tunnels at the [illegible] not nearly enough [illegible] from the [illegible] and a considerable portion of [illegible]. It does not seem possible that the [illegible] handling, storage and transportation effected by the [illegible] could possibly justify the reduction [illegible] amounting to over 15 per cent.

A. M. SHAW,
Consulting Engineer.

New Orleans, La.

Some Gains from High Prices*

So much has been said about the evils of high prices for commodities and service that it may be well to give a little attention to the other side. The compensations of high prices are neither few nor insignificant. In coal, for instance, it has been pointed out for years that we are very wasteful in our manner of consumption, and the rejoinder has often been made that it really does not pay to save coal. But it might be better if a smaller percentage of the population were devoted to producing coal so that the men released could be adding to our supplies of other things; also if a smaller proportion of our railroad capacity were used for transporting coal, permitting the released capacity to carry something else.

If a coal consumer has been using 5,000 tons of coal a year, costing him $10,000, it would be better for society if he made improvements so as to get along with 2,000 tons of coal and the 2,000 tons still cost him $10,000. The consumer is entitled to be served with coal, but society is better off if only two-fifths as much work is done in serving him.

The cost of erecting dwelling houses is extremely high and that works untold hardship upon the people, but the high cost causes architects to study as never before to economize in labor and materials, and to produce the most attractive and efficient designs. If it costs $10,000 instead of $5,000 to build a certain sized house, more brains will be put into the architecture. The result is more pleasing to the passerby, and valuable experience is gained, which will remain when building costs come down.

The cost of labor is very high, and this induces men to think harder than ever before to devise means for saving labor. That is an economic advantage that cannot be lost. A labor-saving idea or device once introduced would hardly be abandoned if the cost of labor came down.

Locomotives and freight cars are extremely high priced, and in consequence railroad managers will endeavor to get more miles per day from both, and it is to be hoped will endeavor to have them so handled as to reduce time lost for repairs. The fewer cars and locomotives needed to render the requisite service the better, for society is saved the trouble of building them, the material is saved, and fewer miles of track are required for the rolling stock to run upon.

The great cry today is that in this period we are extravagant, but the extravagance referred to is chiefly an extravagance in the use of money. From our present viewpoint, however, we can see that in times past we were extravagant in the use of materials and labor. As a whole people we are not so seriously hurt by extravagance in personal expenditure, for the money simply passes from one hand to another. When we are extravagant with materials and labor, on the other hand, we all lose. Society loses when things are not done efficiently, and high prices have promoted many kinds of efficiency.

---

*An Editorial in July 1 [illegible]

Construction Costs Unaffected by Recent Price Flurries

[illegible] looking drop in response to the flurry [illegible] the country is [illegible] experiencing? [illegible] is the answer of the Aberthaw Construc[illegible]

[illegible] aspects of the present situation are [illegible] notably ob[illegible] the Aberthaw statement which was is[illegible] the latter part of last month. [illegible] to be ob[illegible] the present price decline has been confined pri[illegible] to commodities that are dependent for their sale[illegible] considerations of style and [illegible]. Some allied [illegible] have slumped in sympathy. Further extracts from the statement follow:

An unseasonable spring season, deliveries delayed beyond the period of normal demand for goods, the call for immediate payment of loans, all these forces have been fully discussed as explanation of the present situation. None of these would have any considerable influence upon building material. It is, of course, conceivable that, here and there, dealers will shade prices on belated shipments of supplies for which substitutes may have been found and which hence threaten to tie up funds, or to call for excessive handling, or, temporarily, to congest storage yards.

But such "soft spots" will be the exception—they will doubtless be offset by increased costs in other directions. It must be understood that, industrially and domestically the United States is years behind in meeting a building schedule commensurate to its increase in wealth and population. The need for building is almost as basic as the need for food. No one in his right mind expects early decline in the price of the latter; nor will there be in the former.

There is for the moment, it must be recognized, a slight decline in structural demand. Manufacturers are hesitating to make commitments for further plant expansion. This is partly due to fear as to market conditions; partly to unwillingness of bankers to advance funds. We look upon this hesitation as temporary. The volume of production necessary to meet the requirements of the American people today can hardly be secured except through plant enlargement. The cheapness of production essential to a normal and steady purchasing demand is unattainable without supplementing increased volume by materially increased human and mechanical efficiency.

Unless history reverses itself, human efficiency will be amplified more by the genius of the inventor and the engineer than by conscious effort on the part of working men. That will involve plant revision on a huge scale. We shall be greatly surprised if the next few years do not witness a scrapping of obsolete factories hitherto unparalleled in the annals of industrialism.

We shall be surprised, too, if funds are not shortly forthcoming to meet urgent building needs. No one better than the banker appreciates the desirability of increased production or the impossibility of it without enlarged facilities. When speculative accounts are deflated there should be [illegible] insufficiency of funds for legitimate operations.

As for the future market for commodities: We presume that if all the cold storage warehouses were forced to sell their [illegible] the next week or two, most people would [illegible] and save money in the eating; and [illegible] they might lose some of their interest [illegible]. But we should hardly advise the hens to stop [illegible] on that account!

[illegible] national [illegible] now is the rail[illegible]. [illegible] plight the American public are col[illegible]. They are paying the [illegible] now of [illegible] and selfish policy which, for [illegible] the railroads [illegible] propor[illegible] the cost of [illegible] the nation's business. Merchants, [illegible] general public all [illegible] enough [illegible] of the [illegible] the [illegible] railroads. [illegible] expend[illegible] or in [illegible] many [illegible]

[illegible] to the [illegible] of the situation, the people now insist upon, and will secure, the essential expansion of rail facilities. But in addition to the daily losses incidental to existing transportation difficulties, a tremendous money premium must be charged against the attempt to supply in months the deficiencies which should have been met by normal annual expenditures during close to a decade.

Yet we should consider the staggering cost of an inept railroad policy well justified if it should teach America as a people the uselessness, and, what is more, the hazard of jockeying with economic law. But the lesson will not be accepted. The story of the rise and fall of nations is largely the story of the ceaseless human attempt to evade, cajole, confuse or completely to ignore economic law—and the eventual and usually relentless triumph of that law.

In the immediate instance, however much we deplore the selfishness of so-called profiteers, we foresee that the usually occupied method of dealing with them must eventually tend to decrease production and to intensify the very conditions which the action taken is designed to prevent.

There are two ways of seeking social results—one is by discouraging the bad; the other, by encouraging the good. There is little bad which has not its element of good; and no good which does not contain potentialities of bad.

For a generation, by legislative enactment and executive procedure, this country has concentrated on discouraging the bad. As a result, the people find themselves in a tangle of suspicion, selfishness and fear that threatens to paralyze individual initiative and neutralize all progressive community effort.

It is high time to shift to the encouragement of the good; for only in that direction does improvement lie. And, just as there is a danger of killing the good when destroying the bad, it must be realized that, with the vital growth of the good there is certain to occur the development of abuses. But humanity being what it is, and will be for some centuries to come, it seems better to accept the risks of growth rather than those of stagnation.

Farming folk have discovered that the best way to combat certain weeds and pests is to fertilize and cultivate the threatened crop to a robustness that enables it to withstand the attacks of various enemies. Only occasionally is it found necessary to cut and burn. A little more farm experience would do human society a great deal of good in a great many ways.

Imitating Building-Rock in Stucco

By HJALMER LINDQUIST.

A concrete stucco wall simulating rock, differs from the ordinary stucco wall only in finish and coloring. The work is not difficult nor does it take as much time as appearances seem to indicate.

The expanded metal lath, or netting, is given two coats of stucco mortar, the usual mixture and put on in the usual way. (Half-inch coats of 1 cement to 1½ sand for good work. Lime is not necessary, though some prefer to use it. A neat cement grout, applied with a brush between coats just before adding the next, improves the wall.) The work might be finished in the second mortar coat but three coats will do a better job.

The first coat needs scratching to bind it to the other, and the second also, in three-coat work, to bind it to the third which is to follow. The third and final coat of 1 cement to 2½ sand, with hydrated lime equal to about 1/20th part of the cement used, is plastered over the second coat when that has set. The lime in this final coat makes a mortar that can be better worked in finishing the detail and it also makes a mortar that is easier to stick to the wall when putting it on. The larger amount of sand used gives a sandy effect after the brushing by showing through the plaster.

The rock blocks are marked out in this final coat, while green, and the detail built up on their surface. The wall that is to imitate odd sizes and shaped rubble stone can be scratched out in blocks with the point of a small trowel with no other aid than the eye to guide the lines, but the square and oblong stone rubble, or stones that fit in layers or equal thickness, will require a straight-edge or a stretched line in marking out the horizontal grooves. The short perpendicular joints that divide these layers into parts may be measured by rule, guessed at [illegible] after a board pattern.

Before starting to mark out the [illegible] well for the workman to study a [illegible] of stone that he is to imitate [illegible] him as a model. A small photog[illegible] wall that can be held in the hand [illegible] is probably even better. The [illegible] the original are easily caught and [illegible] need not be slavishly followed. [illegible] have been made the photo[illegible] laid aside and referred to only [illegible] inspection.

The rock detail on the face of t[illegible] is built up with mortar on the [illegible] each block separately. A rather flat [illegible] such as that of a quarried granite rubble [illegible] shown in Fig. 1, will require but little [illegible] while other rocks that have [illegible] When this bulge is [illegible] be large it is sometimes necessary to [illegible] on the block a little at the time [illegible] as much mortar as will stick to the [illegible] a little before applying more, working [illegible] stones in the meantime and then return[illegible] to the first one and thus keep building [illegible] until the desired bulge is had. The [illegible] detail is then added and if a cut stone [illegible] the small effects also are added around the edge line.

Figure 2 is a natural sandstone wall of [illegible] scaly without much bulge. The imitation [illegible] the main features of the scaly effect. This was done by sticking thin layers and dabs of mortar to the blocks, letting it set for a while and then finishing the work off better by scraping.

The rubble stone, Fig. 5, was done much the same way. It took less mortar and the scaly [illegible] on the surface were omitted. Short broken [illegible] were made instead by adding little dabs of mortar, smoothing them down on one side to nothing while the other edge less than ½ in. [illegible] was left untroweled.

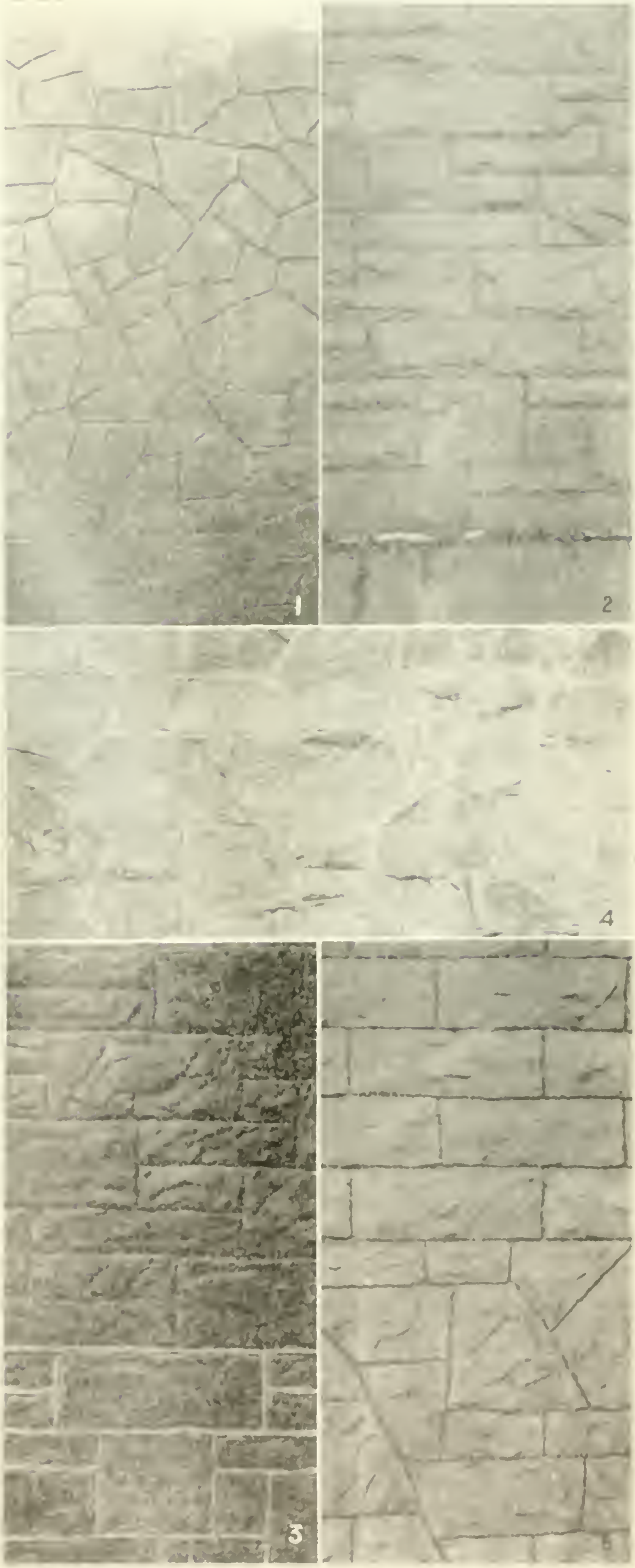
The natural rubble wall, Fig. 4, shows some of this scaly effect but not so much as the imitation, Fig. 3, lower half. The effect was heightened in an effort to produce something more pleasing to the eye. Assembling effective features for striking effects is the work cut out for the artist and everything is well if he does not go too far beyond the modesty of nature.

Finishing greatly improves the looks of this rock work. If enough mortar has been stuck to the blocks much of the finer detail can be cut in with the trowel point at this time. The blocks are scraped, when the mortar coat has partly set so as to be in workable condition, about three hours in summer, with the small trowel, to remove all smooth trowel marks left when applying the final coat. The detail is also cut out deeper and otherwise sharpened up.

After scraping, the plaster surface is brushed over with a whiskbroom, with a wire brush first if set a little too hard for the broom. The pebbles of sand are thus exposed and threads of sand formed in the rock face by striking in one direction.

Coloring improves the wall still more. An artificial sandstone wall will want but one color, while the granite rubble imitation requires a variety of hues. The four colors, red, brown, yellow and black, when scattered over such a surface and intermingled by sprinkling water lightly over them, gives a natural effect.

In this matter of coloring there is much room for individual taste, but the color of natural rock should not be departed from too widely lest the work prove fantastic and ridiculous. The best cement colors should be used for this surface



Examples of Imitation of Building Rock With Stucco [illegible] [illegible]ating. The cost will not prove expensive because a little coloring goes a long way. The colors are made permanent, or nearly so, by adding copperas to them when mixed in water. A little dissolved clay is also added to make the coloring look more natural.

A half pint of copperas solution (the [illegible] crystals dissolved in one water over night [illegible] water to [illegible] much of the chemical as [illegible] that time a [illegible] gallon of the color mixed in separate vessels. A [illegible] of thin liquid clay is about right.

The coloring may be applied to the surface with a syringe or [illegible] with a brush. If put on a little thick it can be [illegible] by sprinkling over gently with water. Weathering [illegible] months makes the coloring more natural [illegible] colors are used they should intermingle [illegible] places so as not to leave any sharply defined color line.

The [illegible] can be jointed with mastic after the work has been colored, left untouched, or colored with some hue that contrasts with the rest of the work.

The [illegible] of these might be improved by using aggregates in the final mortar coat, crushed sandstone or granite for [illegible] for the wall that imitates these stones. This [illegible] thing has not yet been tried and its worth must be tested by other experimenters.

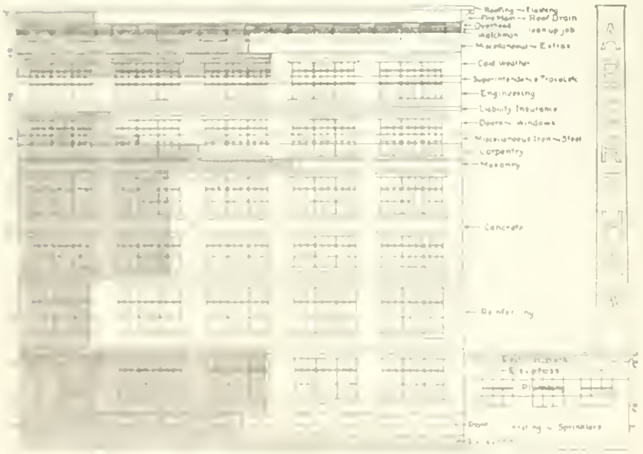
In the illustration (1) indicates odd size rubble stone marked out on the concrete surface and colored without any rock detail or brushing. (Coloring effects do not show in photographs.) (2) A wall of natural sandstone. A slatey kind of sandstone. (3) An imitation of figure two in concrete [illegible]. Partly jointed. (4) A natural granite rubble. (5) Layer stone and rubble imitated in concrete with groves [illegible] colored black.

Graphic Building Costs

By C. E. PATCH,

Aberthaw Construction Co., Boston, Mass.

In the construction of a concrete building, where accurate cost figures are kept for every part of the operation, with subdivisions covering material, labor, etc., on each operation, a mass of statistics is built up which is of interest and



[illegible] Illustration of Cost Items Entering Into Construction of Manufacturing Building.

[illegible] the [illegible] almost unintelligible to the layman. [illegible] this form of information more readily appreciable by [illegible] living with the subject day by day, this [illegible] sketch has been made.

The [illegible] various elements placed one over the other [illegible] order in which they occur during the [illegible] of the building. Each is proportional in height to the percentage which it represents of the total cost of the building. Thus the excavation shown at the bottom is 3.05 percent of the structural cost. The largest item of all [illegible] the total. At the right has been [illegible] figure, the height of which represents the percentage which the various subcontracts bear to the structural cost of the building. The items covered here are [illegible] work, [illegible], plumbing, heating and [illegible] [illegible] percent to the structural cost of the building. Here again each item is shown with height proportional to its cost, and to the costs in the main building.

In the building structure, as drawn, each item has a shaded portion at the left end. This portion represents the percentage of that item which was expended for direct labor by the contractor. The portion not shaded represents materials and other necessary expenses.

The drawing has been set up in the form of a manufacturing building with its adjoining power plant, in order to visualize more clearly the case under discussion. As the stories are added one by one, for the various materials as they are added, each structure is built up until finally, with the roof, we have reached 100 percent of the total cost.

The percentage marks, shown at the left, give a ready measure of the extent of the several items in the particular building from which the present diagram was constructed. The various items of cost as represented in percentages are shown in the table. The first column of figures represents the item cost as compared with the total structural cost of the building. The second column of figures compares the item cost with the total cost of the building, including all sub-contracts for building equipment.

	Percentage referred to	
	Structural cost of building.	Total cost including sub-contracts.
Concrete	24.0	19.2
Reinforcing	16.0	12.76
Forms	11.6	11.8
Engineering	5.5	4.50
Cold weather	5.2	4.25
Doors and windows	5.2	4.15
Plant	4.6	3.85
Miscellaneous and extras	1.5	3.6
Excavation	3.7	3.05
Carpentry	3.7	3.05
Masonry	2.5	2.08
Fire main and roof drains	2.3	1.95
Miscellaneous iron and steel	2.2	1.85
Overhead	1.56	1.28
Superintendence, travel, etc	1.50	1.23
Roofing and flashing	1.36	1.12
Liability insurance	0.62	0.51
Watchman	0.54	0.45
Clean up job	0.42	0.35
Heating and sprinklers	59.7*	11.20
Plumbing	15.3*	2.93
Elevators	14.6*	2.86
Electrical work	10.4*	1.98

*Of total cost of equipment sub-contracts.

Efficiency of Industrial Labor Increasing

The efficiency of labor is increasing, according to reports from 49 manufacturers operating in 40 different lines of industry in New York City, which are summarized in the July 19 Bulletin of the Merchants' Association. This testimony is submitted to the Industrial Bureau of the Merchants' Association by the same manufacturers who reported in September, 1919, that in general labor was not more than 70 per cent efficient, judged by normal standards. Although production per man per hour has not yet reached normal, it has been gradually improving since last September, especially during the last four or five months, and a spirit of optimism regarding the productivity of labor is now prevalent among manufacturers. It is not possible to measure the increase in output on a percentage basis except in special cases, and it cannot be said that the increase is as yet remarkable, but the testimony is unmistakable that a change for the better is now well under way. Of the 49 manufacturers who reported, 23 say that the efficiency of their employes has increased noticeably since last September; five say that although they have seen no measurable increase, they sense a better spirit among their employes; 17 say that they have observed no change; and three say that they have noted a decrease. One manufacturer reports that it is his observation that labor efficiency is increasing in many lines of industry, although he has available no specific data for his own plant. The reasons given for the present tendency toward increased productivity per man are varied, but those most frequently cited are the increase in the number of applicants for positions and the change from time work to piece work. Some manufacturers report also that there seems to be a better class of labor available, and two or three make this statement particularly in reference to female labor. On manufacturer says that a decided increase in individual efficiency occurred from a closed shop to an open shop policy.

Methods of Constructing Substructure of Thames River Railroad Bridge, New London, Conn.*

By JAMES W. ROLLINS

Of Holbrook, Cabot & Rollins [illegible] Mass.

The problem of constructing a railroad bridge across the Thames River at New London, Conn., was a most complex one, the river being about 1,400 ft. wide, the water 50 ft. deep at the center of the river, and rock bottom 100 ft. to 150 ft. below water level. When the question of a bridge at this location was first discussed in 1856 it was considered to be beyond the limit of finance and the engineering resources of the day, and not until 1889 were these difficulties removed and the bridge built and opened to traffic with proper ceremonies on Oct. 10 of that year. It was a double-track structure, 1,432 ft. long, with a draw span of 503 ft., this span remaining the longest in the world for many years.

About 1905 the old bridge began to move, and some of the piers settled to such an extent that in 1908 the traffic was cut down to a single "gauntletted" track.

Studies were then begun for a new bridge. A profile of the river bottom at the site of the new bridge is shown in Fig. 1.

Various studies were made as to type of foundations: First, a pile concrete grillage, open-caisson type; but this was finally abandoned on account of the failure of the old bridge, which was built in this way.

At the request of one of the engineers of the N. Y., N. H. & H. R. R., the writer at one time made a study, report and estimate of this type, and is still of the opinion that a modern type of construction of the pile open-caisson method would have been as satisfactory and stable and much less expensive than the open-crib construction plan, which was finally used.

The worst condition affecting the piers was in the center of the river, where the water was 50 ft. deep, mud and clay 80 ft. thick—a total distance of 130 ft. to suitable gravel foundation.

The writer's plan was to dredge out 20 ft. of mud, fill the hole up to 10 ft. with crushed stone, and then drive piles 75 ft. long through the crushed stone into hard gravel and sand stratum, sawing off piles at —60, filling up balance of dredged bottom with riprap to [illegible] the original bed of river. The mansonry would then [illegible] on a concrete reinforced grillage [illegible] the piles.

The writer believes that in the [illegible] of this type for foundations some question arose as to the effect of this dredging and pile driving on the old bridge foundations, the center lines of the two bridges being only [illegible] ft. apart, and possibly this fear led to the abandonment of the pile open caisson method.

A four-cylinder open caisson was also studied, but abandoned on account of the doubt as to being able to control the sinking of these cylinders to the great depth necessary.

The final and accepted study was for rectangular open crib caissons, and after most extensive borings had been made the final plans were drawn, bids were asked for and contract awarded to Holbrook, Cabot & Rollins Corporation in March, 1916.

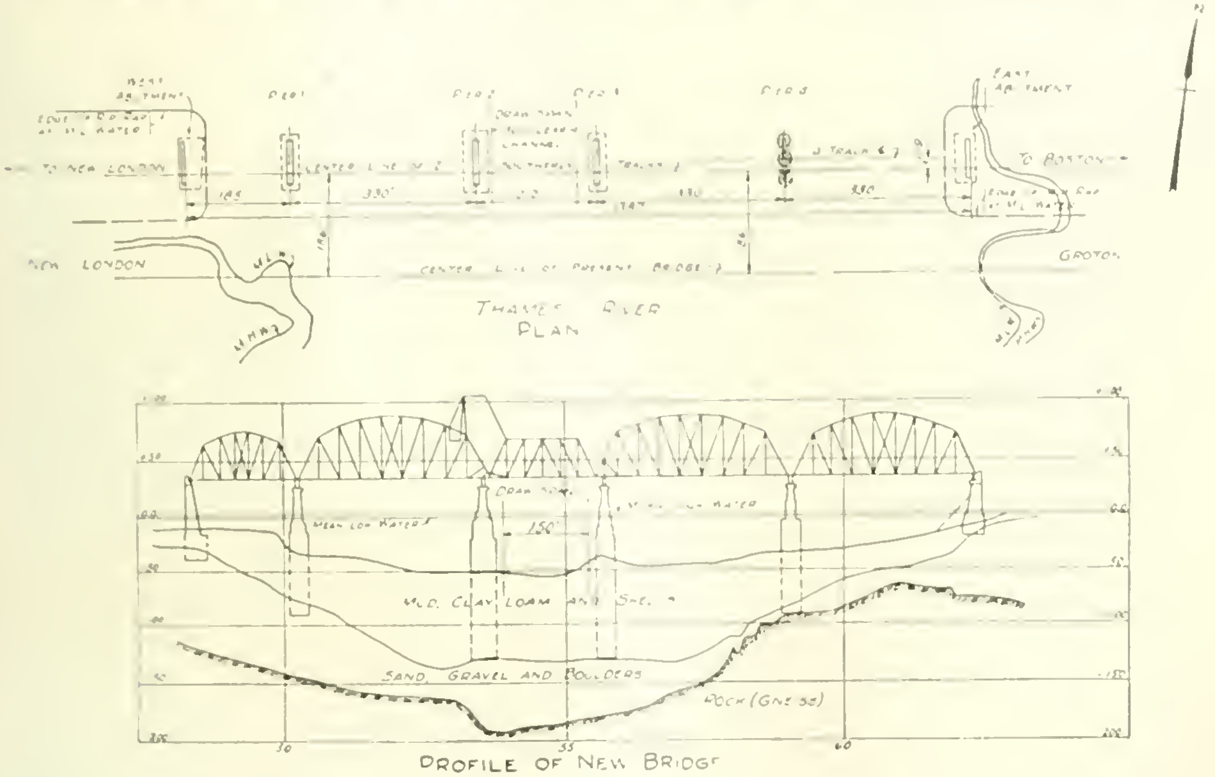


Fig. 1—Plan and Profile of New N. Y., N. H. & H. R. R. Bridge Over Thames River at New London, Conn.

Contract Conditions.—The terms of the contract were somewhat novel, and were as follows:

The contractor guaranteed that the cost of the foundations according to the plans submitted would not exceed $875,000, that any excess cost above that sum was to be paid by the contractor, and any saving of cost below the above sum would be divided equally between the contractor and the Railroad Company. The contractor was to be given a fixed fee of $80,000 for doing the work.

This plan worked out most satisfactorily, as the railroad company paid at once for all material bought, and under these conditions we bought all the material for the whole job, and piled it up for use as needed; so that with the possible exception of gravel for concrete, we did not have to wait at all for material.

Another great advantage in this form of contract where both the company and the contractor had a direct money interest in the cost (as we divided the saving) was the close and cordial co-operation between engineers and contractor, to do the work in the most economical manner. Everybody worked for the best interest of the job, no pet schemes or new theories were tried out, for we all realized that we had a most difficult problem, which was a new one for all of us, and that it needed thought, brains and the most diligent attention, in order to be carried through with success.

Construction of Cribs and Concrete "Cutting Edges."—The contract plans provided for two abutments on gravel foundations: the westerly abutment 10 ft. below water, the easterly abutment 20 ft. below water; and for four piers:

---

*Abstract of a paper presented April 21 before the Boston Society of Civil Engineers.

[illegible] it and [illegible] built on [illegible] to [illegible] The [illegible] [illegible] cutting edge [illegible] the [illegible] of [illegible] of the [illegible] cutting edge [illegible].

[illegible] developed [illegible] then [illegible] on [illegible] rein-forced [illegible] the necessary [illegible] the com-

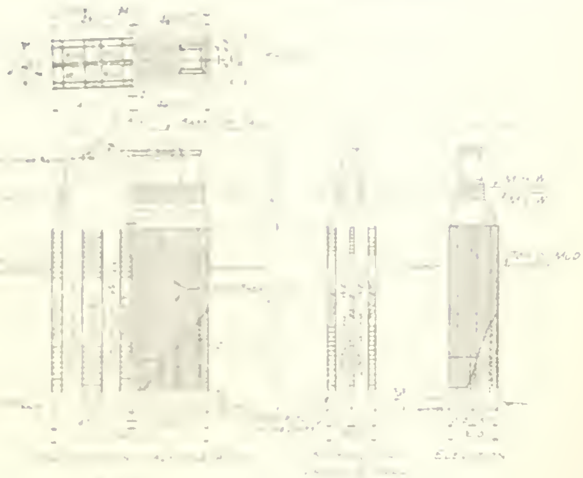


Fig. 2.—Plans and Sections of Pier No. 3.

[illegible] drawing 20 ft. of water, when there were [illegible] available for that depth of water and [illegible] special ways for this work was prohibitive. [illegible] ship railway with an extreme draught of [illegible] consideration was given to some method of con-[illegible] would permit the use of this railway on which to [illegible] cutting-edge sections. It was at once seen that [illegible] the air spaces in the dredging wells [illegible] for with this space available the draught of the [illegible] section was reduced to 13 ft.

[illegible] by building a solid floor of 4-in. plank on [illegible] timber, this floor being calked on the bottom, [illegible] the entire crib on this plank floor, making [illegible] connection between the floor and the out-[illegible] edge, and finally holding the floor tight to the [illegible] from the 12 in. by 12 in. cross timbers on [illegible] was built, up to timber across the top of the crib.

[illegible] the pressure against the false bottom at the open [illegible] at the bottom of the dredging wells, heavy trusses [illegible] the concrete in all the dredging wells, so [illegible] to allow their removal after the false bottom [illegible] from the crib. These trusses are shown [illegible].

[illegible] entirely successful, and cribs were built [illegible] to about 20 ft. in height, floated off the [illegible] to the site of the work, and then built [illegible].

[illegible] bottom, the cables were loosened, and [illegible] through the dredging pockets on to the tem-[illegible] and when enough was dumped to overcome the [illegible] it was detached from crib and [illegible] the river and then the crib was [illegible] ready for sinking.

[illegible] of [illegible] timber, solid [illegible] lateral tim-[illegible] on the [illegible] dredging well. The [illegible] connection with the [illegible] bolted on all [illegible].

Accident to Crib at Pier 2. [illegible] developed on [illegible] at the [illegible] of Pier 2 was [illegible] to fill with water, the crib began to sink, and finally brought up on the bottom of the river, in 50 ft. of water, with the top timbers of the crib about 12 ft. under water; and, to add to our misfortune, this crib was sunk on the exact site of Pier 2. We then were up against the proposition of raising a crib weighing 2,000 tons, sunk in 50 ft. of water; and right here began the co-operative working of brains and igenuity, to solve the problem.

First it was asked: Why did the crib sink? And after a little talk and brain work, the question was answered. When the false bottom was loosened from the crib the water filled the dredging wells, which were water-tight, and this brought the resultant hydrostatic pressure on the sides of the dredging wells, which were surrounded by open air spaces, which later were to be filled with concrete.

The sides of the dredging wells of 12 in. by 12 in. timber were only fastened together by two ¾ in. by 18 in. drift bolts, and these could not hold the pressure of the water, so the joints in the corners of the dredging well opened, and the water filled the air spaces, so entirely voiding the flotation power of the crib, with the 1,500 tons of concrete on the bottom cutting-edge section.

We sent divers down to examine the wreck, and they reported that the crib was practically level and the false bottom had not been entirely knocked loose from the crib, and when the crib sunk it went back on to the plank bottom in practically its original position.

Luck was surely with us in this, for otherwise it would have been practically impossible to float the caisson, and would have necessitated its destruction and removal—a wrecking job of appalling possibilities, especially as the wreck was on the site of Pier 2.

However, with this false bottom in place, our proposition was easy. We built a section of the crib, about 12 ft. high, floated it into position, and with weights sunk it on to the top of the submerged crib. As all pieces were alike in the crib, this section exactly fitted on to the submerged crib, and we clamped it down on to the lower section with bolts and cables, and calked the joint with divers; also we went over the old joint between the crib and the false bottom and calked that tight. This construction brought the top of the crib above the water level, and then all we had to do was to pump out the water in the dredging wells, and the crib floated. In this way we very easily go out of what might have been a most serious calamity.

Jetting System for Controlling Sinking of Cribs. To provide for some small control in sinking the cribs through 80 ft. of mud, clay and gravel, and to help relieve the friction, an elaborate set of jets was built in the cutting edges: two jets in the wall of each dredging pocket, in diagonal corners, and three on the outside of the crib on each side, at the ends and in the center. The pipes were 4-in. in diameter, with nozzles of cast iron made to connect with these pipes, the opening in nozzles being ¾ in. All the pipes in a dredging well were connected into one pipe at the top of the dredging well, which pipe was built around the entire top of the caisson, and to which was coupled a compound duplex pump, 12 in. by 20 in. by 12 in. by 15 in., with a 12-in. suction and 8-in. discharge, with a capacity of 1,130 gal. per minute at 165 lb. pressure. This pump was installed on a flat boat, with a boiler of 250 HP. furnishing steam at 150 lb. pressure to run the pump. (Fig. 5.) Although much time and money were spent on this jetting system, it was not a success, for the power in the jets was not enough to do efficient work in clay, and after a short time this plan was abandoned, and a single vertical pipe was used with a horizontal pipe at the bottom, 2 or 3 ft. long, with a nozzle of 1¼ in. With all the power concentrated on to one noz-

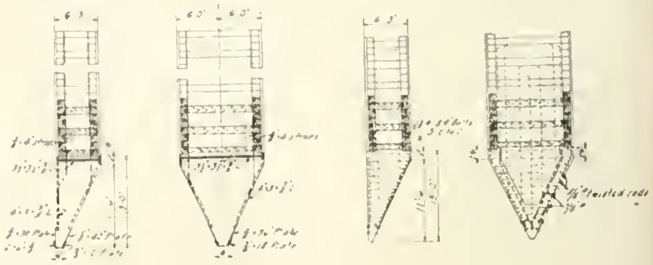


Fig. 3.—Section of Crib Showing Cutting Edges.

zle tremendous pressure was developed which fairly tore the bottom of the river up, undermining oysters and everything else within its reach. This small jet pipe was very flexible as we could lower it into any pocket or on the outside of the crib at any point where we [illegible] the crib was being held up.

Pier 2 took an ugly slant when about [illegible] ft. down, and it took a lot of "jockeying" of the [illegible] to get excavating in the necessary pockets, and [illegible] others with concrete and stone, until finally the crib was sunk to grade and straightened up, with the [illegible] about 2 ft. out of position. As this caisson was [illegible] ft. wide there was plenty of room for adjustment of the [illegible]. In a gravel stratum it was easy to control the sinking of the crib, but the clay at times seemed to vary [illegible] and tend to make the crib slip.

As before stated, Piers 1, 2 and 3 were founded on wooden [illegible] sunk by dredging through open well, into a gravel stratum, [illegible] ft. to [illegible] ft. below water level, the rock in this portion of the river being from 115 ft. to 185 ft. from water level.

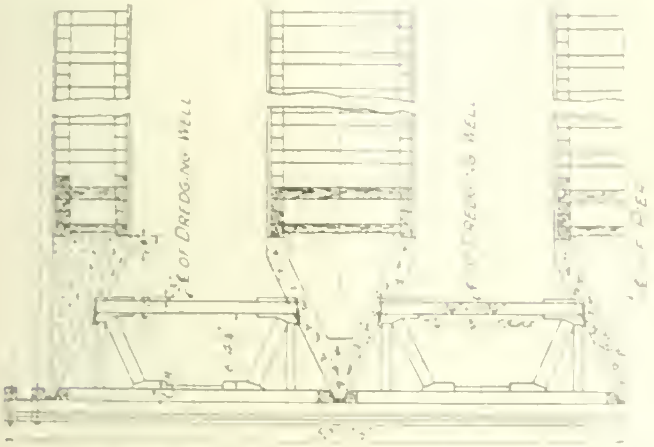


Fig. 4—Method of Constructing False Bottom.

For Pier 4 a rock bottom was attainable at elevation —70 to —1[illegible], the rock surface dropping up stream across the foundation at an approximate angle of 25°.

Cylinders with Metal Cutting Edge on Pier No. 4. The original plan was for two cylindrical piers, 28 ft. in diameter. On account of the great declivity in the rock this plan was abandoned and three cylinders of 22 ft. adopted; the tops of the cylinders being at grade —9, and the solid masonry pier beginning at that elevation.

These cylinders had a heavy metal cutting edge, with an air shaft in the center 8 ft. in diameter. The outside shell above the plate iron cutting edge, which was 15 ft. high, was built of wooden staves 4 in. thick, with suitable bander hoops on the inside to which the staves were bolted, these outside staves being braced like a wheel's spokes to the iron air shaft. These cylinders were built on the marine railway to a height above flotation line, launched and floated down the river to the bridge site.

This was another interesting problem. The water at this pier was 35 ft. deep, with a stratum of mud, shells and clay 26 ft. thick below that, making the proposition of a cofferdam around the cylinders an expensive one, requiring 55 ft. to 60 ft. sheeting.

The final plan was to sink the cylindrical caissons to rock by pneumatic process, build the masonry to grade —9, and then fill up the air shafts and pockets with concrete, leaving the timber sides in position above high water.

A very accurate survey was then made of the relative position of the three piers, and plans drawn showing the results.

We then made a rectangular caisson of heavily reinforced concrete, 22 ft. by 90 ft., and 6 ft. high, and which we christened the "bathtub"; this caisson was about 1 ft. larger each way than the base of the masonry pier which was to be built on it. In the bottom of this caisson we left holes about 15 ft. in diameter, the centers of these holes corresponding to the center of the cylindrical piers already sunk. Cross walls were built in the caissons cutting out these holes, so as to get the sufficient air space for the flotation.

We [illegible] that light [illegible] pockets of the "bathtub" [illegible] at [illegible]. This bathtub caisson was [illegible] railway and launched from it.

We had built in the top sections of the cylindrical piers a large number of heavy [illegible] and bent them [illegible] so as to float the caisson into position. We also built into the concrete of the piers [illegible] holes to set up a gasket to keep the water out of the open pockets in the caisson.

When all was ready we floated the bathtub off the railway, towed it down river to the bridge site, and warped it into exact position over the three foundation piers, and then sunk it on to them. The gaskets worked well, and we had no difficulty in pumping out the open pockets in the "bathtub," straightening out the reinforcing rods, and filling the whole structure with concrete up to elevation —3, i.e., the bottom of the masonry, finishing that to above high water level, then removing the wooden sides.

The construction of the piers above the high water mark was ordinary water work, and was completed without any trouble.

The granite belt consisted of six courses, which protected the piers against action of the water between tidal limits. To maintain and preserve the joints in the granite masonry the joints were calked hard with "wool lead."

Construction Plant. The plant for this job was very extensive and met fully all the requirements of the work.

The concrete, of which there was 57,000 cu. yd. used, was all mixed in a floating mixing plant, an old car float, the "Coney Island," 195 ft. by 35 ft., with a derrick at one end, space in the center for storage of [illegible] tons of sand and gravel. Under the decks below this storage pile was a 24 in. belt conveyor which carried the sand and gravel to the [illegible] end of the boat into an elevator carrying the material up into a hopper, 30 ft. above the deck. The material was dropped from this hopper into the concrete mixer and into a bucket, at bottom of a tower. The mixed concrete was raised in the tower and spouted into place in the piers, or into a bucket on the lighters for final handling.

When we got the caissons down to a foundation satisfactory to the engineers, we began to fill up the dredging pockets, which were 8 ft. by 12 ft. in section, and 130 ft. deep. We deposited the concrete through a 12 in. tremie, up to —60, and then pumped the water out and finished the concrete in the wells in the "dry."

When we pumped the water out of the first dredging wells we found to our dismay about 8 ft. of "laitance" on the top of the concrete. We had some difficulty in getting this out on account of the free lime present, and the heat the moving of the laitance developed. Again, the men did not relish working down in that shaft, 80 ft. deep, with a bucket going up and down over their heads. We, later, excavated this laitance with a clamshell bucket, before it had set up, and had no more serious trouble from this cause.

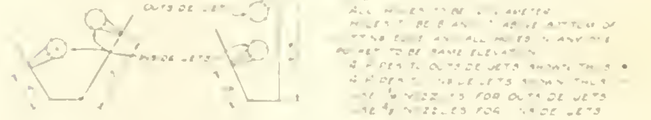


Fig. 5—Arrangement of Jet Nozzles.

The statistics, in part, on this bridge are as follows:

Total length of bridge, 1,387 ft.; being made in five spans, from west to east, of 185 ft., 230 ft., 212 ft. draw span, 330 ft., 230 ft., respectively.

The work on the foundations was begun April 20, 1916, and was finished Aug. 9, 1917, 57,114 cu. yd. of masonry being placed at an average cost, including everything, of $16.36 per cubic yard.

The total weight of the load on superstructure is esti-

[illegible] at [illegible] and was erected at a total cost of $162 per ton.

All the work on these foundations was done under the direction of [illegible] officers of the New York, New Haven & Hartford R. R.: Mr. Edward Gagel, chief engineer; Mr. W. H. Moore, engineer of structures; Mr. L. [illegible] Waterman, engineer of construction; Mr. P. B. Spencer, resident engineer; Mr. W. H. [illegible], chief inspector. And for the contractor, Mr. Luke S. White acted as superintendent and Mr. [illegible] Lozat, assistant superintendent, the writer representing [illegible] Cabot & Rollins Corporation, the contractors.

Highway Bridges and Culverts*

By M. A. LYONS.

Chief Engineer Provincial Road Board of Manitoba.

In selecting the type of structure three factors will influence this choice, viz., economy, service and appearance, and of these the first two will generally, but not always rightly, be the deciding factors. It is impossible to estimate the value of the æsthetic in design, and, as this value cannot be expressed in concrete symbols, it is frequently not understood, and, consequently, beauty of appearance is not given full value in deciding on the type of structure. It is a question as to how much additional money should be spent in order to achieve a pleasing appearance. The cost of a bridge is, however, soon forgotten, but an unsightly bridge cannot be forgotten, for it remains as a constant unpleasant jar on the senses.

Comparative Costs of Timber, Steel and Concrete Bridges.—In selecting the most economical type of bridge, first-cost upkeep and value of non-interruption of traffic must be considered. The timber structure is in about every case the cheapest in first cost, but in the long run it does not generally prove to be as cheap as steel or concrete. A wooden pile bridge, if suitable for the site, is no doubt the cheapest bridge in direct cost.

For example, a 50-ft. pile bridge will cost today about $1,500. Allowing 6 per cent interest, a yearly payment of $270 would be required to keep this bridge in condition, made up as follows: Flooring to be renewed every 3 years, first cost $270, yearly payment for 3 years $101; stringers to be renewed every 6 years, first cost $270, yearly payment $55; remainder of bridge to last 12 years, first cost $960, yearly payment $114; total yearly cost $270. Indirect costs, such as delay to traffic during repairs, loss of traffic through neglect of repairs liability to accident or fire may run the total cost far beyond the direct costs. At best, the pile bridge is very unsightly and only to be considered where first costs are of prime importance, as they sometimes are.

In many cases stream conditions are such that it is not permissible to have piles in the stream bed and a clear opening of long span is required. The type of structure may then be a choice between a wooden span, a steel span or a concrete span. Unless the wooden span is to be placed on piles, which, in many cases, is not feasible, the cost of the substructure for the three types will be about the same, so that it will only be necessary to compare the relative costs of the superstructure. Again selecting a 50-ft. span for comparison, and assuming wooden flooring to be renewed every three years, wooden stringers to be renewed every six years, painting wood and steel to be carried out every four years, the life of concrete and steel to be over 30 years and the life of a wooden truss to be 15 years, we have the following relative costs:

FIRST COSTS.

Wooden Truss—	
[illegible] ft. B. M. timber at $100 per M	$1,240
[illegible] lb. steel at [illegible] per lb.	450
[illegible]	250
	$1,940
Steel Truss—	
[illegible] at $[illegible]	$2,772
[illegible] ft. B. M. timber at $80 per M	368
	$3,140
Concrete Bridge—	
[illegible]	$2,380
[illegible]	1,160
[illegible]	370
[illegible] steel at [illegible] per lb.	200
[illegible]	200
	$4,310

YEARLY COSTS.

Wooden Truss—	
Flooring, 2,800 ft. B. M. at $80, cost $221, yearly payment based on 3-year life	$ 84
Stringers, 3,200 ft. B. M. at $80, cost $256, yearly payment based on 6-year life	54
Remainder of bridge $1,210, yearly payment based on 15-year life	125
Yearly cost of painting every 4 years	72
Total yearly cost	$ 335
Steel Truss—	
Timber, 4,670 ft. B. M. at $80, cost $374, yearly payment based on 3-year life	$ 140
Yearly payment on steel truss for 30 years (cost $2,772)	201
Yearly cost of painting every four years	36
Total	$ 377
Concrete Bridge—	
Yearly payments on concrete bridge for 30 years (cost $4,310)	$ 311

It thus appears that the concrete superstructure, for spans of this length at least, is cheaper than either wood or steel. It must also be noted, in the case of steel and concrete bridges, that at the end of 30 years the bridge is paid for and the yearly payments cease (except for the repairs on the steel bridge), while in the case of the wooden bridge the yearly payments still go on.

Every Bridge a Problem in Itself.—For bridges of any size it is impossible to make any general statement that one class of bridge is cheaper than another, as every bridge is a problem in itself, and the foregoing is given as an example of a method of obtaining relative costs. The question of the nature of the foundations, cross-section of the stream-bed, condition of stream flow, waterway required, availability of materials, relative cost of materials, relative costs and availability of labor, relative cost of substructure to the superstructure, ice conditions and economical and suitable length of span must be taken into account when deciding which is the economical bridge.

Wooden bridges are confined chiefly to two types, the pile trestle and the Howe truss. For steel bridges of clear span of 30 ft. or under, simple stringer spans are cheapest; from 30 ft. to about 45 or 50 ft., plate girders; from 50 ft. to 80 or 90 ft., low or pony trusses; 400 or 500 ft., trusses with subdivided panels; beyond this, cantilever or suspension bridges, with steel arches, coming in any place in the list.

Every concrete bridge is a study in itself. In Manitoba there have been constructed, or are under way, slab and girder bridges up to 30-ft. span, through girders up to 50-ft. span, barrel arches up to 100-ft. span, open-spandrel arches up to 60-ft. span, through arch or rainbow type up to 90-ft. span and bowstrings up to 90-ft. span. These are, however, only given as an example of different types of concrete bridges.

In appearance the concrete bridge can be made to surpass any other kind of bridge. It can be poured into any form, and beauty must lie in its lines and not in any ornamentation. It offers an opportunity for its designer to give a structure that will be a constant pleasure to beholders, and which will be in mind long after the cost is forgotten. There is still another strong argument for the use of concrete, and it is that the materials used in the making of concrete are almost without limit.

Culverts, Types and Costs.—Coming to the small but important culverts, there are, in general, four types in common use: First, wooden culverts; second, steel or iron culverts; third, concrete pipes; and fourth, concrete culverts cast in place. The wooden culvert is undoubtedly the cheapest, but the objection to this is that it is out of commission or unsafe about most of the time. In point of cost, concrete pipe culverts come next. These, however, must be placed where no water will freeze in or around them, and they must have a good, solid bed. Considerable saving has been effected in Manitoba by the use of concrete pipe, and the results have been quite satisfactory. The cost of manufacture last year ran about as follows:

	Per lin. ft.
10-in. diameter	36 ct.
12-in. diameter	45 ct.
15-in. diameter	50 ct.
18-in. diameter	83 ct.
24-in. diameter	$1.22
30-in. diameter	1.75

The breakage in handling ran about 1 per cent.

Corrugated steel or iron pipes have been used extensively where lack of suitable materials or labor prevent the making of concrete pipes. These can be laid in places where it would not be suitable to lay concrete pipes. We have also used semi-circular reinforced concrete culverts cast in place with success. These cost about the same as the corrugated iron pipes. We seldom use pipe culverts of over [illegible]-in. or 36-in. diameter. Above that we use reinforced concrete box culverts.

---

*Abstract of a paper [illegible] Good Roads [illegible]

Designing of Bridges.—All bridges should be designed by competent engineers. The design of ordinary steel bridges is so well standardized that there is not much difficulty in getting a suitable bridge after the loads that it may be called upon to carry have been decided upon. The fixing of the proper loading will require careful study, and in the end it must remain largely a matter of judgment.

The tendency up to the present has been to increase the weight of loads carried on highways. Many bridges have been discarded recently owing to the fact that they were not heavy enough for present traffic. At the present time the heaviest likely load appears to be a motor truck. In Manitoba, we design our floor system for a concentrated load of 18 tons, plus 30 per cent, and our trusses for the same load or of a load of 100 lb. per square foot, whichever produces the greater stress. The tendency appears towards lighter tractors rather than towards heavy ones. Before these bridges are worn out, however, some of them may be called upon to support heavy truck loads, but it is doubtful if these will ever exceed 18 tons.

The design of the foundation is most important. The bearing power of different soils varies so greatly, and similar soils vary so greatly under different conditions, that careful examination must be made of the soil in order to properly design a foundation. It is a strange fact that there are probably less data on the variable factors in the behavior of soils than on most other materials of construction, and therefore, the assumptions made in the design of foundations is largely a matter of experience and judgment.

The design of reinforced concrete structures is not so well standardized as the design of steel bridges, and structures should not be considered which have not been designed by a competent and experienced engineer.

Inspection of Material and Construction.—Proper construction is just as essential as proper design. Great care must be taken in the selection of the material. For steel bridges the material rolled by steel mills is so nearly standard that for ordinary bridges there need be no hesitation in accepting structural shapes. But in order to eliminate poor field riveting, enlarged rivet holes made by drifting in erection, and other faults which may produce stresses for which no provision has been made, all shop work should be carefully inspected before the material is shipped to the job.

In reinforced concrete work the inspection must be more rigid. The cement should be subjected to standard tests before it is used. The making of cement is a delicate process, and any one of several factors entering into its manufacture may cause a variation in the product. Especial care should be given in the selection of the aggregates, these must be well graded and absolutely clean. It is probable that more failures occur through the use of improper aggregates than from any other cause. The water used must be clean and just the right proportion used. Prof. Abrams has shown that the proportion of water to cement is one of the big factors affecting the strength of concrete. The amount of water used should be just enough to make a workable mix, and any greater proportion of water rapidly decreases the strength of the concrete. There is only a certain amount of water required to cause the setting up of the cement, and it is quite evident that any amount beyond this, when it has dried out, leaves voids in the concrete.

The inspection of the steel is also very important not only to discover quality, but to ensure that the bending is done according to plans. It is a common idea that any sort of steel will do for concrete reinforcing, but such is not the case. This steel is designed to take its share of the stress fully as much as the steel in a steel bridge. It must occupy the exact space it is designed for, otherwise it is of no use in the structure. For this reason the bends shown in the plans must be strictly observed.

It is also important to have experienced contractors for concrete work, and inspection of construction is just as important as inspection of the material. This inspector must be a man who knows his business better than the contractor, and who has sufficient tact and judgment to get the work properly carried out without undue hardship to the contractor. It is a mistaken idea that any cheap person will do for an inspector.

The form work is very important in concrete work, as it must be strongly built to withstand the pressure that will come upon it. It must also leave a smooth surface, for every flaw in the forming shows up in the finished structure. Careful ramming of the concrete is necessary in order to make a dense concrete, to prevent voids forming next to the forms and to ensure a close bond between the concrete and steel.

New York City Regulations for Design of Reinforced Concrete Flat Slabs

The Board of Standards and Appeals of New York City on July 8 adopted revised rules governing the design of reinforced concrete slabs in that city. These rules follow:

Application.—The rules governing the design of reinforced concrete flat slabs shall apply to such floors and roofs consisting of three or more rows of slabs without beams or girders supported on columns, the construction being continuous over the columns and forming with them a monolithic structure.

Compliance with Building Code.—In the design of reinforced concrete flat slabs, the provisions of article 16 of the building code shall govern with respect to such matters as are specified therein.

Assumptions.—In calculations for the strength of reinforced concrete flat slabs, the following assumptions shall be made:

(a) A plane section before bending remains plane after bending;

(b) The modulus of elasticity of concrete in compression within the allowable working stresses is constant;

(c) The adhesion between concrete and reinforcement is perfect;

(d) The tensile strength of concrete is nil;

(e) Initial stress in the reinforcement due to contraction or expansion in the concrete is negligible.

Stresses.—(a) The allowable unit shear in reinforced concrete flat slabs on the bd section around the perimeter of the column capital shall not exceed 120 lb. per square inch; and the allowable unit shearing stress on the bjd section around the perimeter of the drop shall not exceed (60) lb. per square inch, provided that the reinforcement is so arranged or anchored that the stress may be fully developed for both positive and negative moments.

The extreme fibre stresses to be used in concrete in compression at the column head section shall not exceed 750 lb. per square inch.

Columns.—For columns supporting reinforced concrete flat slabs, the least dimension of any column shall be not less than one-fifteenth of the average span of any slabs supported by the columns; but in no case shall such least dimension of any interior column supporting a floor or roof be less than 16 in. when round nor 14 in. when square; nor shall the least dimension of any exterior column be less than 14 in.

Column Capital.—Every reinforced concrete column supporting a flat slab shall be provided with a capital whose diameter is not less than 0.225 of the average span of any slabs supported by it. Such diameter shall be measured where the vertical thickness of the capital is at least 1½ in., and shall be the diameter of the inscribed circle in that horizontal plane. The slope of the capital considered effective below the point where its diameter is measured shall nowhere make an angle with vertical of more than 45°. In case a cap of less dimensions than hereinafter described as a drop, is placed above the column capital, the part of this cap enclosed within the lines of the column capital extended upwards to the bottom of the slab or drop at the slope of 45° may be considered as part of the column capital in determining the diameter for design purposes.

Drop.—When a reinforced concrete flat slab is thicker in that portion adjacent to or surrounding the column, the thickened portion shall be known as a drop. The width of such drop when used shall be determined by the shearing stress in the slab around the perimeter of the drop, but in no case shall the width be less than 0.33 of the average span of any slabs of which it forms a part. In computing [illegible] moment on [illegible] the width of the drop only shall [illegible] the compressive [illegible] of such drops be [illegible] Where drops [illegible] shall [illegible] extend to the [illegible] of the capital.

Slab Thickness. [illegible] concrete [illegible] the formulas [illegible] and t = [illegible] thickness [illegible] slab in [illegible] pounds per [illegible] less than [illegible] for floors, [illegible] of the slab [illegible] than [illegible] for [illegible] than 5 in. [illegible]

Reinforcement. (a) In the calculation of moments at any section [illegible] bars which cross that section [illegible] that such bars extend far enough [illegible] section to develop the full amount of [illegible] The effective area of the reinforcement [illegible] moment section shall be the sectional area [illegible] such section multiplied by the sine of [illegible] with the plane of the section. The [illegible] reinforcement of the several bands shall [illegible] provide for the intermediate moments [illegible]

(b) [illegible] may be made wherever convenient [illegible] points of minimum stress. The length [illegible] not less than 80 bar diameters and in [illegible] than 2 ft. The splicing of adjacent bars shall [illegible] as far as possible. Slab bars which are lapped [illegible] the sectional area of both being included [illegible] for negative moment shall extend to the [illegible] beyond the column center.

(c) Where the reinforcement is arranged in bands, at least [illegible] of the bars in any band shall be of a length not [illegible] distance center to center of columns measured rectangularly and diagonally, no bars used as positive reinforcement shall be of a length less than half the panel [illegible] 40 bar diameters for cross bands or less [illegible] of the panel length plus 40 bar diameters [illegible] and no bars used as negative reinforcement [illegible] length less than half the panel length. [illegible] framing perpendicular to the wall in exterior panels shall extend to the outer edge of the panel [illegible] hooked or otherwise anchored.

(d) Adequate means shall be provided for properly maintaining [illegible] reinforcement in the position assumed by [illegible]

Line of Inflection.—In the design of reinforced concrete flat slab construction, for the purpose of making calculations of the bending moments at sections other than [illegible] the line of inflection shall be considered [illegible] located one-quarter the distance center to center [illegible] rectangularly and diagonally, from center of [illegible] for panels without drops, and three-tenths of [illegible] with drops.

Moment Sections. For the purpose of design of reinforced [illegible] flat slabs that portion of the section across [illegible] midway between columns, which lies [illegible] two quarters of the width of the panel [illegible] inner section and those portions of [illegible] outer quarters of the width of the [illegible] the outer sections. Of the section [illegible] from column to column and [illegible] edge of the [illegible] two quar- [illegible] section [illegible] projected [illegible] width shall be [illegible]

Bending Moments. [illegible] concrete [illegible] to bending [illegible] In the [illegible] expressions [illegible]

W is [illegible] the panel under consideration, including the weight of drop whether a square, rectangle or parallelogram;

W is the total live load on the panel under consideration;

L is the length of side of a square panel center to center of columns; or the average span of a rectangular panel which is the mean length of the two sides;

n is the ratio of the greater to the less dimension of the panel;

h is the unsupported length of a column in inches, measured from top of slab to base of capital;

I is the moment of inertia of the reinforced concrete column section.

A. Interior Square Panels.—The numerical sum of the positive and negative moments shall be not less than 1/17 W L. A variation of plus or minus 5 per cent shall be permitted in the expression for the moment on any section, but in no case shall the sum of the negative moments be less than 66 per cent of the total moment, nor the sum of the positive moments be less than 34 per cent of the total moment for slabs with drops; nor shall the sum of the negative moments be less than 60 per cent of the total moment, nor the sum of the positive moments be less than 40 per cent of the total moment for slabs without drops.

In two-way systems, for slabs with drops, the negative moment resisted on two column head sections shall be—1/32 W L; the negative moment on the mid section shall be—1/133 W L; the positive moment on the two outer sections shall be + 1/80 W L and the positive moment on the inner section shall be + 1/133 W L; and for slabs without drops, the negative moment resisted on two column head sections shall be 1/36 W L, the negative moment on the mid section shall be—1/133 W L, the positive moment on the two outer sections shall be + 1/63 W L and the positive moment on the inner section shall be + 1/133 W L.

In four-way systems, the negative moments shall be as specified for Two-Way Systems; the positive moment on the two outer sections shall be + 1/100 W L, and the positive moment on the inner section shall be + 1/100 W L for slab with drops; and the positive moment on the two outer sections, the length L shall be assumed as the distance cen- the inner section shall be + 1/100 W L, for slabs without drops.

In three-way systems, the negative moment on the column head and mid sections and the positive moment on the two outer sections, shall be as specified for Four-Way Systems. In the expression for the bending moments on the various sections, the length L shall be assumed as the distance center to center of columns, and the load W as the load on the parallelogram panel.

B. Interior Rectangular Panels.—When the ratio n does not exceed 1.1, all computations shall be based on a square panel of a length equal to the average span, and the reinforcement shall be equally distributed in the short and long directions according to the bending moment coefficients specified for interior square panels.

When the ratio n lies between 1.1 and 1.33, the bending moment coefficients specified for interior square panels shall be applied in the following manner:

(a) In two-way systems, the negative moments on the two column head sections and the mid section and the positive moment on the two outer sections and the inner section at right angles to the long direction shall be determined as for a square panel of a length equal to the greater dimension of the rectangular panel; and the corresponding moments on the sections at right angles to the short direction shall be determined as for a square panel of a length equal to the lesser dimension of the rectangular panel. In no case shall the amount of reinforcement in the short direction be less than two-thirds of that in the long direction. The load W shall be taken as the load on the rectangular panel under consideration.

(b) In four-way systems, for the rectangular bands, the negative moment on the column head sections and the positive moment on the outer sections shall be determined in the same manner as indicated for the two-way systems.

For the diagonal bands, the negative moments on the column head and mid sections and the positive moment on the inner section shall be determined as for a square panel of a length equal to the average span of the rectangle. The load W shall be taken as the load on the rectangular panel under consideration.

(c) In three-way systems [illegible] and positive moments on the bands running parallel to the long direction shall be determined as for a square whose side is equal to the greater dimension, and the moments on the bands running parallel to the short direction shall be determined as for a square whose side is equal to the mean dimension. The load W shall be taken as that on the rectangular panel under consideration.

C. Exterior Panels. The negative moments at the first interior row of columns and the positive moments at the center of the exterior panels on bands running parallel to the wall shall be increased 20 per cent over those specified above for interior panels. The [illegible] moment on moment sections at the wall [illegible] shall be determined by the conditions of restraint, but the negative moment on the mid section shall never be less than 50 per cent and the negative moment on the column head section never less than 80 per cent of the corresponding moments at the first interior row of columns.

D. Interior Columns shall be designed for the bending moments developed by unequally loaded panels, eccentric loading or uneven spacing of columns. The bending moment resulting from unequally loaded panels shall be considered as 1/40 W L, and shall be resisted by the columns immediately above and below the floor line under consideration in direct proportion to the values of I/L.

E. Wall Columns shall be designed to resist bending in the same manner as interior columns, except that W2 shall be substituted for W in the formula for the moment. The moment so computed may be reduced by the counter moment of the weight of the structure which projects beyond the center line of the wall columns.

F. Roof Columns shall be designed to resist the total moment resulting from unequally loaded panels, as determined by the formulas in paragraphs (D) and (E) of this section.

Walls and Openings.—In the design and construction of reinforced concrete flat slabs additional slab thickness, girders or beams shall be provided to carry any walls or concentrated loads in addition to the specified uniform live and dead loads. Such girders or beams shall be assumed to carry 20 per cent of the total live and dead panel load in addition to the wall load. Beams shall also be provided in case openings in the floor reduce the working strength of the slab below the prescribed carrying capacity.

Special Panels.—For structures having a width of less than three rows of slabs, or in which exterior drops, capitals or columns are omitted, or in which irregular or special panels are used and for which the rules relating to the design of reinforced flat slabs do not directly apply, the computations on the analysis of the design of such panels, shall, when so required, be filed with the superintendent of buildings.

F. O. B. Pittsburgh Price on Steel Case Dismissed.—The Federal Trade Commission on July 24 dismissed the application of the Western Association of Rolled Steel Consumers, comprising 700 western fabricators, for the issuance of a formal complaint against the U. S. Steel Corporation and other steel companies. The case, which has been pending for more than a year had as its object the doing away with the Pittsburgh basing system for fixing steel prices. The complainants contended that this practice in fixing the price of steel actually made and used at such centers as Chicago, Duluth and Birmingham is a discrimination in favor of Pittsburgh fabricators as against fabricators in Chicago, Duluth and Birmingham. It was charged that the practice constituted a violation of section two of the Clayton anti-trust act and also was an unfair method of competition in violation of section five of the Federal Trade Commission act.

San Francisco Spends $400,000,000 for Buildings.—Nearly $400,000,000 worth of building has been done in San Francisco since the fire in 1906. These figures, according to San Francisco Business, the organ of the Chamber of Commerce, represent contracts within the corporate limits of the city and do not include any building operations carried on by the state or Federal Governments or the Panama-Pacific Exposition.

Volume-Moisture Relation in Sand and a Method of Determining Surface Area Based Thereon*

By RODERICK B. YOUNG and W. [illegible] WALCOTT

We are all more or less familiar with the [illegible] space occupied by a given weight of fine aggregate [illegible] to the [illegible] contained in that aggregate. A sand ordinarily occupies more space when moist than when dry. In the course of an investigation undertaken to determine the bearing that this [illegible] have on the problem of proportioning concrete mixtures, it was discovered that this phenomenon was related to the "surface area" of the aggregate involved.

Definition of Terms.—[illegible] the terms "surface area," "bulking," "sand" and "silt" as used in this paper. The "surface area" of an aggregate is the summation of the surface areas of its individual particles, these particles being considered spheres equal in volume to that of the actual particles. The investigations of [illegible] Edwards and others have shown that both the strength and water requirements of a concrete mixture are related respectively to the "surface area" of the aggregates used. Surface area is therefore used in proportioning concrete mixtures as a measure of the cement requirement of the aggregate.

When a sand increases in volume because of an increase in its moisture content it may be said to "bulk." Bulking is expressed quantitatively as a percentage or ratio.

"Sand" is used in its commonly accepted sense, namely, any aggregate derived from a natural source all of which will pass, when dry, a screen having circular openings ¼ in. in diameter.

"Silt" as here used means that very fine material in a sand which will pass a No. 150 sieve.

The tests described in this paper were carried out by the writers in the laboratory of the Hydro-Electric Power Commission of Ontario as a part of an extended research being conducted there into the problem of concrete proportioning.

Material Used in Tests.—The materials used in these tests were sands which had been submitted to the laboratory in the course of its routine examination of aggregates. They came from sundry localities in Ontario and elsewhere, localities quite dissimilar geologically. Most, though not all, would be classed as good concrete sands.

Mechanical analyses were made of each sand from carefully prepared samples taken by the method of quartering. The sieves used were a perforated plate having ¼ in. diameter openings and Tyler's Nos. 6, 10, 20, 35, 65 and 110. Grain counts were carried out on each size of separation for a representative sand from each locality, and from these counts and the specific gravity the surface area was obtained, using the formula

$$A = 236.1 \sqrt[3]{\frac{[illegible]}{n}} \qquad (1)$$

Where A = surface area in square feet per 100 lb., s = specific gravity of the sand, and n = number of grains per gram in any size of separation.

The method of obtaining surface area is essentially the same as that described by Edwards and uses the basic assumption before noted, that the individual particles of sand are spheres. The surface area for any size as determined by the above formula is called the "unit area" for that size.

The increase in volume resulting from additions of moisture was obtained indirectly by determining the weight per cubic foot of the material first dry and then moist. Both ½ and ¼ cu. ft.-capacity cubical measures were used at different times. The measure was filled by means of a cylindrical shell, open at both ends. This was placed in the measure, filled with the sand under test and slowly withdrawn. The capacity of the cylinder being slightly greater than that of the measure, an excess of material remained in the latter when the cylinder was removed. This excess was struck off with a straight edge. Several determinations were made on

---

*Paper presented at 23rd annual meeting of the American Society for Testing Materials, held at Asbury Park, N. J., June 22-25, 1920.

[illegible] results [illegible]. It was noted that the [illegible] results.

Calculations of Moisture in Sands. The [illegible] sands [illegible] degrees of moisture [illegible] predetermined amount of water was added to the dry sand and thoroughly worked into [illegible].

Knowing the weight per cubic foot of [illegible] dry and [illegible] the percentage increase in [illegible] to the [illegible] was calculated from

W [illegible] W

I [illegible] 100 . . . (2)

W

[illegible] per cent increase in volume [illegible] ratio of water

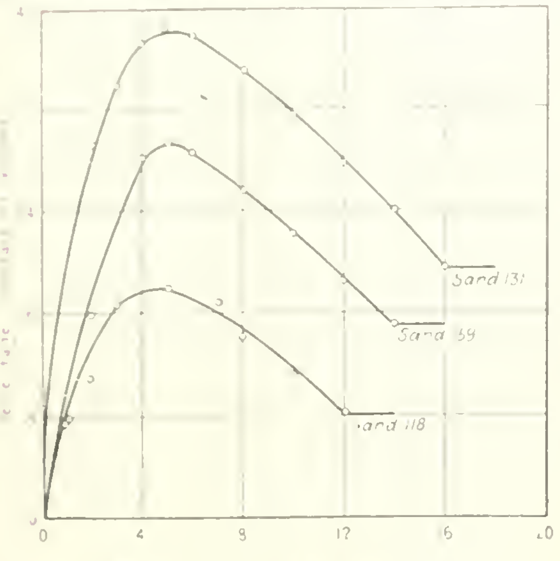


Fig. 1—Relation Between Moisture Content and Bulking in Sand.

[illegible] to weight of dry material, W. = weight per cubic foot of dry material, and W = weight per cubic foot of moist material.

Figure 1 shows the percentage increase in volume obtained in this manner for three sands: a fine, a medium and a coarse. The mechanical analyses of the same sands are shown in Fig. 2. These curves are representative of those obtained throughout this investigation.

A study of these tests revealed the interesting fact that the maximum percentage increase in volume, or bulking, is related to surface area. When plotted against surface area the [illegible] fall [illegible] on a straight line (Fig. 3). The [illegible]

[illegible] . . . (3)

[illegible] square feet per 100 lb. and x = [illegible] per cent.

Relation Between Bulking and Surface Area. It may seem [illegible] surface area is in[illegible] the percentage of water [illegible] it. This [illegible] contents of [illegible] bulking and surface area for one, two and three per cent additions of water. However, to show this relationship it was necessary to plot only results from sands having approximately equal silt content. Other sands of different silt content would not conform to these curves.

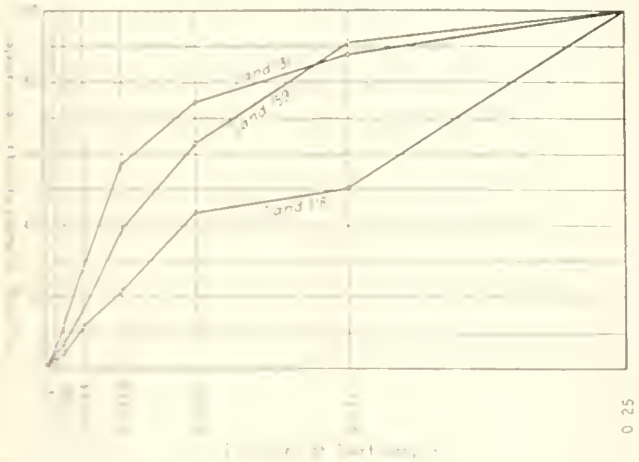


Fig. 2—Mechanical Analyses Showing Range of Sand Used in Investigation.

Any silt contained in a sand will commence to absorb moisture as soon as water is added. This absorbed water takes little or no part in the bulking phenomenon. It is the moisture in excess of that absorbed by the silt that causes changes in volume. Sands of equal surface area but containing different percentages of silt will bulk differently for the same percentage additions of water up to nearly the point of maximum bulking. At that point the variable effect of different silt contents is compensated for.

Experiments were also carried out upon sands having particles of uniform size. These sands were all prepared from one material[1] by sieving it into its different sizes. Volume-moisture studies were then made on each size. These experiments also showed maximum bulking to be related to surface area. But it was found that this relation did not follow the same law as with graded aggregates. It was found that sands coarser than that passing the No. 6 sieve did not increase in volume with additions of moisture. It is thought that the reason for this is that the weight of the particles in these large sizes is sufficient to overcome the separating effect of the film of water surrounding the moistened particle. This explanation has not as yet been tested out experimentally.

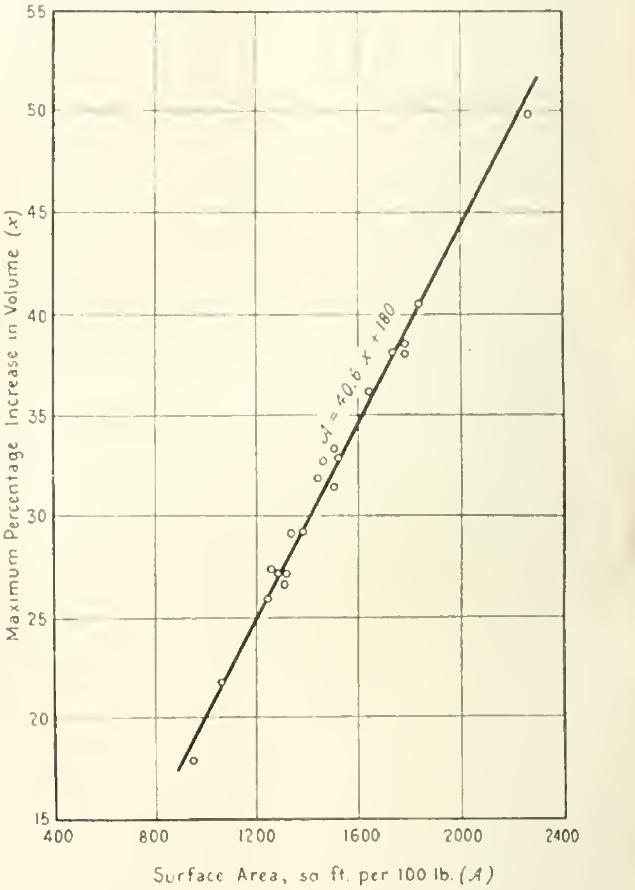


Fig. 3.—Relation Between Surface Area and Maximum Bulking for Graded Sands Embodying Results Shown in Table I.

Figure 5 shows the relation between maximum bulking and surface area for these "one-size" sands. This relation is expressed by the equation

$x = 0.30\, A^{0.612}$ . . . . (4)

where x = increase in volume in per cent and A = surface area in square feet per 100 lb.

A few experiments were made with mixtures of sand and gravel. Only one sand and one gravel were used but these were mixed in different proportions. Here also a relation between bulking and surface area was found. Successive additions of gravel decreased the percentage of maximum bulking in the same ratio as it decreased the surface area. Figure 6 illustrates the results of these few tests.

Maximum Bulking Can Be Determined for Surface Area.—It is at once apparent that if the laws indicated by Figs. 3 to

6 inclusive are general, the maximum bulking of sand or of a sand-gravel mixture could be determined if its surface area was known. Conversely its surface area could be determined if its percentage of maximum bulking was known. It is evident, however, in the bulking of one-size materials that these relationships are not perfectly general since the large-size particles take no part in the bulking phenomenon.

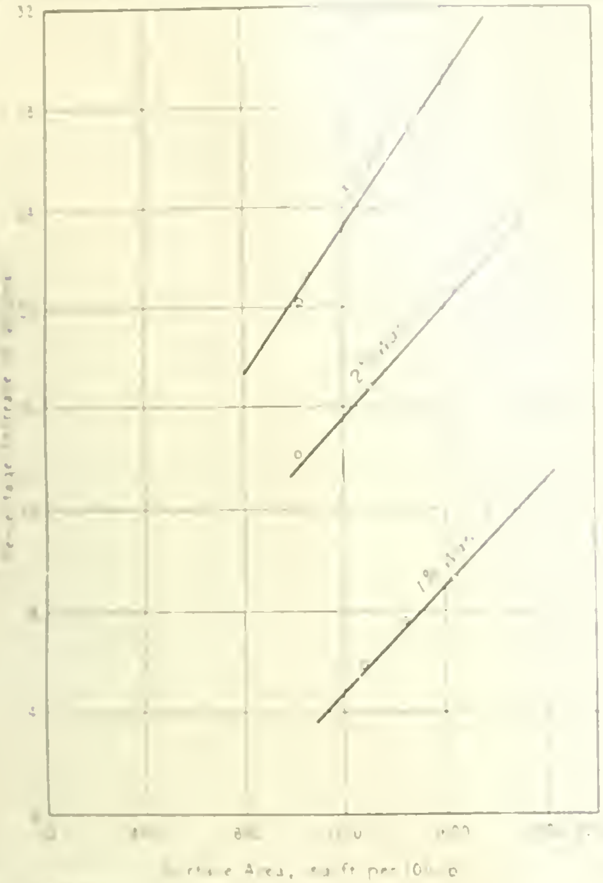


Fig. 4.—Relation Between Surface Area and Bulking for Different Moisture Content.

An experimental study of the limitations within which the conclusions hold have shown that the following is approximately true:

1. Extremely coarse sands, sands in which over 60 per cent by weight will not pass the No. 10 sieve, give results higher than those obtained by mechanical analysis. Sands of these characteristics usually have surface areas less than 1,000 sq. ft. per 100 lb. They will usually be detected immediately by an experienced observer.

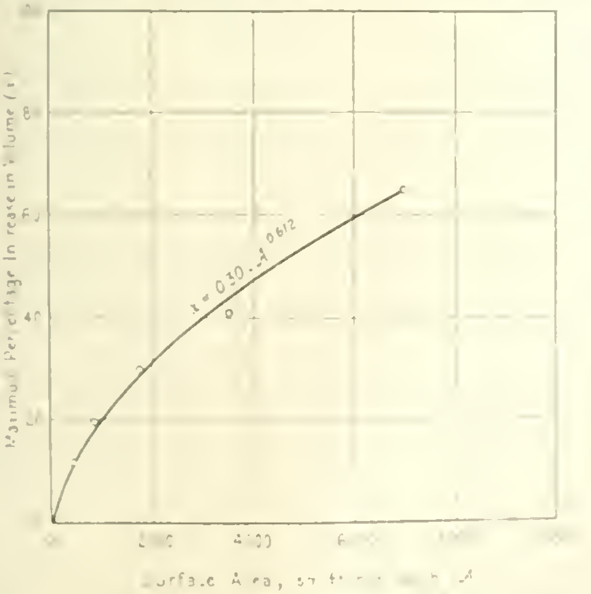


Fig. 5.—Relation Between Surface Area and Maximum Bulking for Sands of One Size.

[illegible]

3. [illegible] lower than 10 [illegible] the effect of the silt is compensated for by the adoption of the [illegible] bulking.

Most sands [illegible] the limits stated. The [illegible] on the relationship between bulking and surface area has two very valuable applications in the science of concrete proportioning.

1. Knowing the surface area and the moisture content the changes in volume of the aggregate can be determined and proportions corrected accordingly.

2. Knowing the maximum increase in volume of a sand due to contained moisture, the surface area of that sand is at once obtainable.

While the first of these is important it is not the subject of this paper and will not be elaborated upon. The second will be taken up at some length.

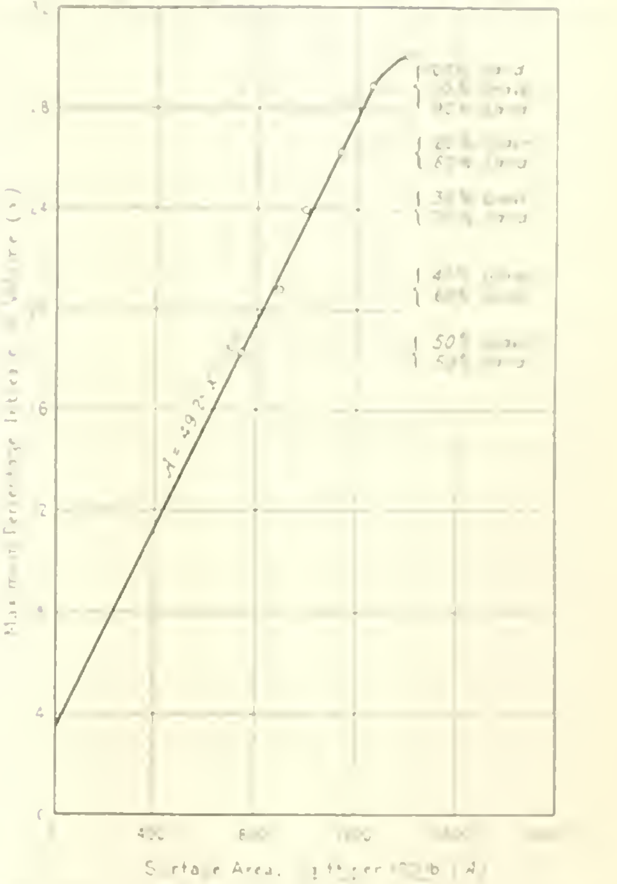


Fig. 6.—Surface Area Bulking Relation for Mixtures of Sand and Gravel.

Method of Obtaining Surface Area of an Aggregate. A method of obtaining the surface area of an aggregate which is both simple and rapid can be based on this relationship between the maximum bulking and surface area.

The weight per cubic foot of the sand to be tested is first determined dry and again after the addition of different percentages of moisture. The additions found to be best are four, five and 6 per cent of the dry weight of the aggregate, the maximum bulking usually occurring in this range except for coarse sands free from silt when it may occur at as low as three per cent. The weight per cubic foot with the lowest percentage of moisture is first obtained; the last two percentages of moisture are then obtained by adding in each case the necessary extra water. The loss of moisture by this procedure has been found to be negligible. Applying successively equations 2 and 3 to these results gives the surface area per 100 lb.

The equipment required is simple. That used by the writer consisted of a ½-cu ft-capacity cubical measure, a [illegible] aggregates [illegible] a [illegible] aggregate [illegible]. This apparatus may be varied [illegible] the [illegible] of the [illegible] results.

[illegible] method [illegible] far [illegible] the method [illegible] simplicity [illegible] requires no [illegible] equipment [illegible] and can be made to give accurate results.

[illegible] obtained by both methods. Here [illegible] have, as is evident from their [illegible] variation in grading. The maximum [illegible] their surface areas as determined by sieve [illegible] as determined by the bulking [illegible] per cent while the average difference [illegible] per cent. This degree of accuracy is within [illegible] error of the sieve analysis method.

The bulking test does not agree with the standard method [illegible] surface area with very coarse sands, very fine [illegible] high in silt. This has already been [illegible]. Table I shows a number of such sands and [illegible] using both methods. It is thought [illegible] to be extremely likely that the surface area determined by the bulking test may be a better measure of the [illegible] working properties of the sand than the values [illegible] from the sieve analysis.

The bulking method has one weak point and that lies in [illegible] the one for the weight per cubic foot. This test is more subject to the personal equation of the operator than is the sieve analysis. It is believed that the rodding method of determining the weight per cubic foot—the method the Society is now considering for adoption as standard—would to a large extent overcome this drawback. Before the rodding test could be used it would be necessary to establish the proper equations linking surface area and maximum bulking, the equations given in this paper only hold for the methods described.

The presence of mica in a sand introduces an interesting problem. Any considerable quantity alters the specific gravity of the material (the number of grains per gram) and hence the unit areas for the different sizes of separation. These unit areas will depend to some extent on the quantity of mica present so that surface areas calculated from them do not give values comparable to similarly graded sands free from mica. The bulking test has been found to give the better values in such cases.

In conclusion, we should like to point out that the tests here presented seem to bear out the contentions of Edwards and ourselves that surface area must be taken into account in any method of proportioning concrete mixtures. It is the opinion of the authors that this bulking of particles occurs in concrete mixtures and that a study of the bulking phenomenon in concrete and its relation to grading of the aggregates as measured by their surface area will throw much light on some of our present difficulties in determining a satisfactory method of proportioning concrete.

TABLE I—COMPARISON OF RESULTS OBTAINED BY MECHANICAL ANALYSIS AND BULKING METHODS OF DETERMINING SURFACE AREA OF SANDS.

[illegible] No.	Sand	Maximum Bulking per cent	Surface Area, sq. ft. Mechanical Analysis	Surface Area, sq. ft. Maximum Bulking	Difference. Sq. Ft.	Difference. Per Cent.
[illegible]	[illegible] Ont.	[illegible]	1517	[illegible]	[illegible]9	+0.59
[illegible]	[illegible] Ont.	[illegible]	[illegible]	[illegible]	—31	—2.28
[illegible]	[illegible] Ont.	[illegible]	[illegible]	[illegible]	[illegible]	—3.71
[illegible]	[illegible]	18.0	[illegible]	[illegible]	[illegible]	—3.60
[illegible]	[illegible]	21.7	1054	[illegible]	—8	+0.75
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7	—0.40
[illegible]	[illegible]	18.5	[illegible]	[illegible]	—13	—2.42
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—6	—0.48
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12	[illegible]3.17
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]15	[illegible]3.00
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.39
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]2.79
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	+2.86
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]2.70
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0.98
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0.11
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	+0.94
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]1.78
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—1.15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—.17
					Average	1.765
[illegible]						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]17.10
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]15.7[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]17.55
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0.67
[illegible]						
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]11.05
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]1.65
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Will Sodium Fluoride Come Into General Use for Preserving Wood?

By GEO. M. HUNT.

In charge, Section of Wood Preservation, Forest Products Laboratory.

The desirability of sodium fluoride as a wood preservative is practically established. The data collected by the Forest Products Laboratory and published in the article by C. H. Teesdale on "Use of Fluorides in Wood Preservation*" are strong evidence to this effect. One large coal-mining company has been using sodium fluoride since 1915 for the treatment of its mine timbers, in preference to either coal-tar creosote or zinc chloride. In the 1919 proceedings of the American Wood Preservers' Association, pages 138 to 145, Galen Wood, chemist of the Port Reading Creosoting Plant, presents evidence of the preservative value of sodium fluoride and the practicability of its use.

In spite of its proved value for the purpose, sodium fluoride is not being used to any extent as a wood preservative except by the single company mentioned above. Other companies have expressed an interest in it, but they have never used it in quantity. The reason for this is obvious when the price of sodium fluoride is compared with that of zinc chloride, which is the standard water-soluble wood preservative. At present sodium fluoride is selling at about 15c per pound, while zinc chloride is purchased in large quantities at approximately 8c per pound. This difference in price prevents the wide use of sodium fluoride in the wood-preservation industry.

Some idea as to the field which might be opened to sodium fluoride in this industry may be obtained from Table 1, compiled by the 1919 proceedings of the American Wood Preservers' Association, which gives for a number of years the annual consumption of zinc chloride in preserving wood and the amount of wood treated with it.

TABLE 1—AMOUNT OF ZINC CHLORIDE USED IN THE UNITED STATES AND WOOD TREATED WITH IT FROM 1909 TO 1918.

Year.	Zinc chloride used, lb.	Amount of wood treated, cu. ft.*
1909	16,215,107	32,678,797
1910	16,802,532	34,804,557
1911	16,359,797	36,814,039
1912	20,751,711	37,803,341
1913	26,166,803	44,772,287
1914	27,212,259	57,352,587
1915	33,269,601	62,819,901
1916	26,746,577	52,075,638
1917	26,444,689	54,311,726
1918	31,101,111	60,385,421

*These figures include wood treated with straight zinc chloride solution and wood treated with mixtures of creosote and zinc chloride.

Assuming a uniform cost of 8 ct. per pound, the amount of zinc chloride used in 1918 represented a value of nearly $2,500,000. At pre-war prices for zinc chloride, the value of this amount would have been in the neighborhood of $1,250,000.

Of the various forms of timber treated with zinc chloride, nearly 95 per cent is in the form of railroad ties, and most of the rest is construction timber. Small amounts are occasionally reported as used for poles, piling, wood paving blocks, cross-arms, and miscellaneous lumber. Reports of the total amount of timber treated in the United States in 1918, the latest year for which statistics are available, show that nearly one-half was treated with zinc chloride.

Since zinc chloride is soluble in water, it will leach out if the treated wood is used in water or very wet locations. It finds its greatest use, therefore, in the drier parts of the country. In the Southern States coal-tar creosote is used in preference to zinc chloride particularly in treating piling to be used in water.

---

*Wood Preserving, January-March, 1917.

Sodium fluoride can be used in the [illegible] manner with the same apparatus, and for the [illegible] purposes as zinc chloride. It possesses [illegible] advantages but its superiority over zinc [illegible] is not sufficient to justify the wood [illegible] greater price for it. A comparison [illegible] ties of these two chemicals which [illegible] wood preserving standpoint is given [illegible]

TABLE I—COMPARISON OF PRO[illegible] IDE AND SODIUM F[illegible]

	Zinc Chloride	[illegible]
[illegible] in water.	Soluble in all proportions.	[illegible]
Toxicity	Toxic enough to materially increase life of wood	[illegible]
[illegible] effect on [illegible]	Somewhat corrosive but is commonly used in steel apparatus.	[illegible]
[illegible]	Can not be successfully painted over	[illegible]
[illegible] of shipment	Shipped in 50 per cent solution or solid but solid form is deliquescent and must be sealed in air tight containers	[illegible]
[illegible] cost	About 8 cents per pound	About [illegible] pound

From the fact that the toxicity or poisoning [illegible] of sodium fluoride is given as over twice that of [illegible] ride, it cannot be argued that it would be twice as [illegible] preservative or that only one-half as much need be [illegible] into the wood to produce the same effect. The [illegible] be determined by laboratory tests only. Such tests must be checked by service tests, where timber is treated and put into actual use, before it can be determined positively that the relatively smaller amount of sodium fluoride [illegible] by the toxicity tests can be safely used. Tests of this kind are under way but it will be a number of years yet before the results are known.

The extent to which sodium fluoride will be used in treating wood, therefore, will depend mainly upon its price. There is little doubt that large contracts for sodium fluoride would be placed if the purchaser could be assured of a price equal to or less than that of zinc chloride. If sodium fluoride should begin to compete sharply with zinc chloride the price of the latter would probably fall. Lowering prices of these two preservatives would encourage treatment and result in a larger volume of treated timber.

The question as to whether it is possible to manufacture sodium fluoride at a price low enough to compete with zinc chloride was recently answered as follows by a man very familiar with manufacturing conditions: ". . . . . you must consider that fluorspar which formerly cost about $1[illegible] now costs about $50, and hardly enough of 'acid quality' is obtainable for this enormous price. Soda ash costs more than twice as much as it formerly cost. Pyrite for the manufacture of sulphuric acid is also much higher than formerly. To this increase in the cost of all material entering into the manufacture of sodium fluoride comes the cost of labor which has more than doubled in the last years. The cost of construction and repairs is also at least twice what it was formerly. Considering all these factors, the present price of sodium fluoride is very moderate. We are well aware that at present prices sodium fluoride can only compete with zinc chloride for special purposes. This applies to sodium fluoride made from hydrofluoric acid and soda ash." From this it is evident that there is no apparent possibility of manufacturing sodium fluoride from fluorspar very cheaply under present conditions.

In the manufacture of fertilizer from phosphate rock it is possible to recover a certain amount of sodium fluoride from the waste gases produced in the process. This is being done in a small way, but it is not a simple process, and a number of plants which have considered it have been deterred from the undertaking because of the chemical difficulties involved, the cost of constructing the required plant, or the difficulty of securing labor and materials. This industry offers a possible future source of cheap sodium fluoride; and, although at present it is not producing much, it is to be hoped that the time is coming when it will be possible to furnish the wood preserving industry with an ample supply at an economical price. The ingenuity of our chemists should make available for general use a material having such desirable wood preserving properties.

Welded Joints and a Nomenclature for Welding*

By WILLIAM T. [illegible]

[illegible]

[illegible]

[illegible]

Already 90 per cent [illegible] who have thoroughly investigated the subject are convinced that welded joints can be made more than 100 per cent efficient for strength [illegible] that 100 per cent strength welds can be [illegible] by [illegible] operators.

The development of welded [illegible] the [illegible] of the [illegible] of riveted work and the substitution therefor of welded joints in the construction of [illegible].

In my dealings with this relatively new art I have [illegible] featured the word "jointure" as indicating the act of [illegible] or condition of being joined at a common point [illegible] structural members.

[illegible] I employ the expression "fillet weld," "butt weld," etc., to describe the mass of metal deposited as a [illegible] for the jointure of a plurality of members [illegible] homogeneous mono-structure, as by welding at their [illegible] edges.

These may be called "unified" or "[illegible]" structures.

If further definition be required it should be understood that the cast weld material, e. g., the weld is in reality a [illegible] and therefore has its limitations as to tensile strength, ductility and elongation. As we progress in our development of the art we shall no doubt learn to convert our [illegible] or other metal welds into jointures of high quality just as we learned long ago to convert our steel ingots into forgings.

The mere fact of our not having attained this proficiency in welding should not defer its progressive adoption for, even though we wholly ignore ductility and elongation in our catalog of virtues, its tensile strength and adaptability for multitudes of shapes of jointures places it far in the lead of riveting.

By using welded jointures we obtain maximum strength with minimum weight of parts. We effect great savings in the construction cost by eliminating various processes such as templating, punching, riveting, chipping and caulking plates, slotting or notching beams and plates for inserts, shaping and forging difficult brackets and angles, and the many other operations akin thereto.

It is not claimed that the actual welding of plating joints is more rapid or less expensive than riveting, but, considered as a whole, welded construction can be executed more rapidly and with less expense than the aggregation of operations which, together, constitute riveted construction.

By no possible means can a riveted joint be made stronger or more durable than the plate itself, neither can the loss of strength due to perforating a plate be regained, even in part, by filling the hole with a rivet. With welding it is only necessary to slightly increase the area of section to obtain a joint having 100 per cent plus efficiency.

Welding Nomenclature.—It is my belief that a very limited nomenclature, with not more than three or four characteristic symbols, will meet every requirement of intercommunication between drafting room and shop. If the foreman welder can be given a simple yet definite direction as to the strength or pressure requirements, plus arrangement of structure usually found on drawings, he will no doubt be fully competent to properly interpret that direction and perhaps execute the work more efficiently than he would with a drawing so filled with symbols and legendary directions as to place its interpretation far beyond the capacity of any ordinary mechanic.

Every arc weld of whatsoever form may be classed as a fillet weld (F), butt weld (B) or a plug weld (P), as may be better understood by reference to Figs. 1 to 8 inclusive.

---

*From a paper, "The [illegible] of Welded Ships," presented April [illegible] before the [illegible] of the American Society of [illegible] Draftsmen.

According to position these become flat, side or overhead welds as, for illustration in Fig. 1 the F welds are flat whilst the B is shown as an overhead butt weld. By turning Fig. 1 to position shown as Fig. 2, B and F becomes side welds and F an overhead weld.

By turning Fig. 1 still further to position as in Fig. 3, B becomes a flat weld while both F and F are overhead weld.

In Fig. 4 the B and F welds are differently combined to produce a butt strap weld or jointure, yet no essential change need be made in the instructions required for the proper interpretation of shop drawings which are usually complete at least to the extent of showing the assembly of parts.

In Figs. 5 and 6 the plug weld (P) is introduced as a means of attaching angles or other like members to plating. This form of weld is a cheap but very efficient substitute for riveting and does not require any perforating of plates.

Figs. 7 and 8 show another application of the F welds. If only one of the plate edges is to be welded, a single F can be used for its designation, but if both edges are welded the joint may be referred to in specification as FF and the symbol F shown against each plate edge on drawing.

Further than above, it does not seem necessary to venture in the exploitation of symbolic directions for welding.

In conclusion let me suggest that in the preparation of drawings and shop orders for the fabrication of welded structures the designer should keep constantly in mind the lesser dimensions of the plating required because of substituting some butt joints for the customary riveted laps.

He should also take advantage of the many opportunities for eliminating angles and other junction members so essential for riveted jointures but wholly unnecessary in electrically welded seams.

It is recommended that the designer consult freely with the welding engineer when developing the layout of new work as between them more efficient and economical results are secured.

It should also be borne in mind that no holes are required in plating or shapes either for permanent jointures or assembling.

The latter consideration, the special development of the welding art and its accomplishment emphasizes the possible elimination of the laying out of all operations accessory to riveting and the greater portion of all mold loft and template work.

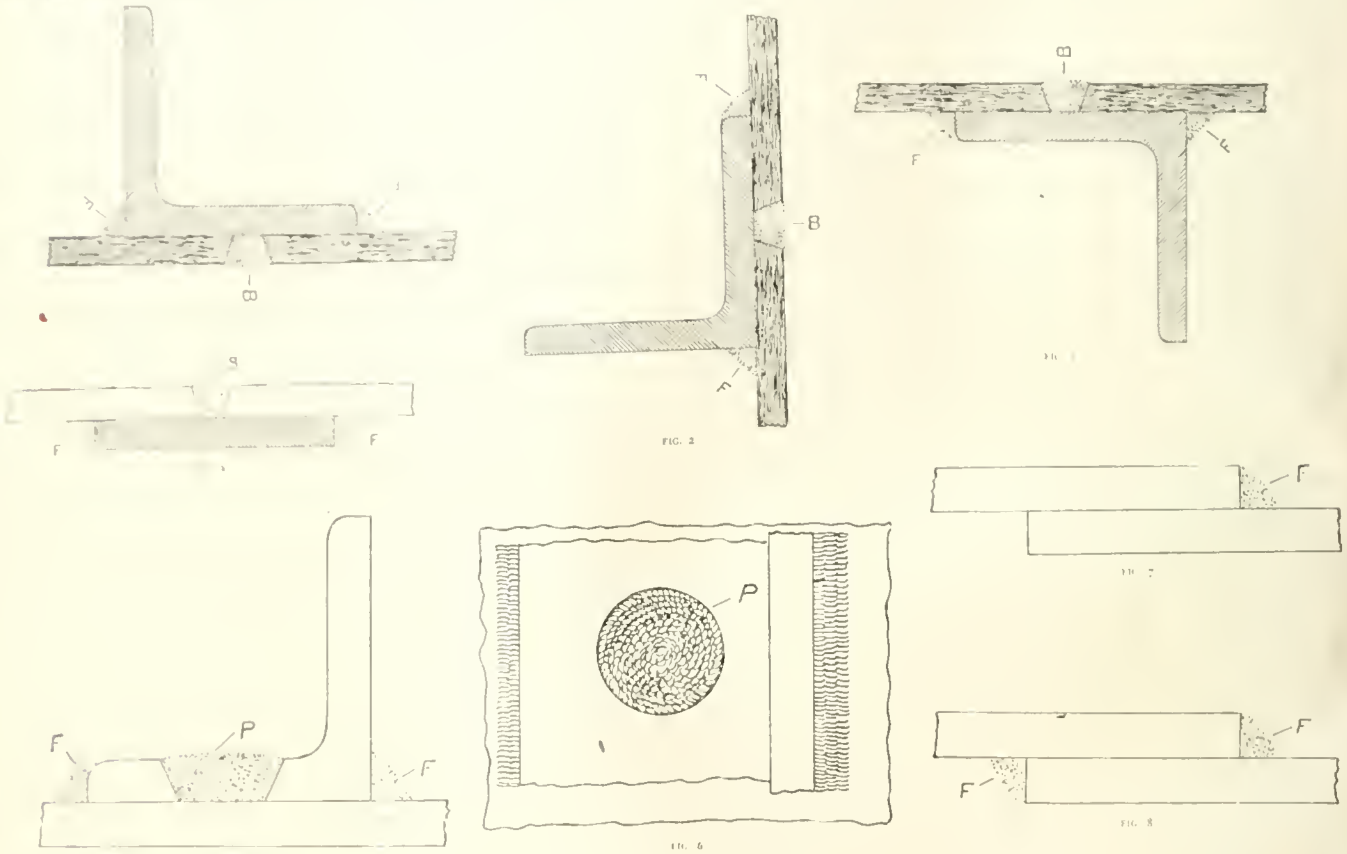
A Study of Definitions of "Professional Engineer" and "Engineering"

(By Alfred D. Flinn with the Collaboration of Alfred W. Kiddle and Harrison W. Craver.)

When Engineering Council's Committee on Licensing of Engineers early in 1919, began its task of framing a model bill for the registration of engineers, it seemed desirable to include in this bill a definition of "engineer" and "engineering." Many attempts at such definitions were made by the Committee and by the Secretary of Engineering Council, aided by several other persons, the chief contributors being Alfred W. Kiddle, Esq., of Kiddle and Margeson, New York, patent attorneys, Associate of the American Institute of Electrical Engineers, and Director Harrison W. Craver, of Engineering Societies Library. The results of these labors are worth recording for the convenience of future inquirers.

Many definitions of "engineer" and "engineering" were found in dictionaries, encyclopedias and engineering literature. Others were drafted. None proved adequate for the purposes of a statute, for none was found sufficiently comprehensive for the modern profession of engineering which did not also include architecture and possibly other professions of the applied sciences. The Committee on Licensing of Engineers concluded that it was impracticable to write a definition suited to its purposes. Furthermore, a definition did not seem essential to a law providing for the registration of engineers. It was deemed sufficient to assume that courts, commissions and juries would know what an engineer was for the purposes of any case just as they would know what a doctor or a carpenter was. Therefore the recommended bill was drafted without a definition of "engineer" or of "engineering."

For the purposes of legislation a suitable definition should be so worded as to stand the test of trial in court; should include all branches of the engineering profession, to be regulated by the law, but not other professions, and should exclude those men who, by an unfortunate duality in the English vocabulary, are also called engineers, although engaged in a different vocation. In other words, the legal definition should include all the varieties of professional engineers to



Figs. 1-8.—Types of Welds.

be governed by the given law and comprise all the functions constituting their professional practice but should exclude the men who run engines, an equally worthy but different vocation. Definitions of "engineer" and "engineering" have been essayed by many persons. In framing them it should be remembered that definitions written for the purpose of a statute must be somewhat different from those to be placed upon tablets or included in laudatory statements about the profession. Both kinds of definition should be stated in such terms that they would not soon become obsolete.

Both Mr. Kiddle and Mr. Craver made many helpful suggestions and aided in this compilation in more ways than one. Mr. Kiddle compiled from numerous dictionaries and encyclopedias a most interesting "Bibliography of Definition on 'Engineer' and 'Engineering'" and drafted tentative definitions as bases for discussion. He suggested, also stated in detail, as fully as possible, all the functions included in all branches of modern professional engineering, exclusive of military engineering, so that this statement could be used in testing and revising the drafts of definitions. Director Craver made a search of engineering literature and selected a number of definitions which it seemed worth while to place in the collection. Others have been added from reports of committees and from laws for licensing of engineers. During the past few years the cognomen, engineer, has attained great currency and breadth with corresponding indefiniteness. It is frequently used in the popular prints to mean any or all of the applications of science to industry and commerce. Many adjectives are now often used with "engineer" which only a few years ago would not have been granted the privilege of such company.

This study is not exhaustive of the subject. It is simply a product of the available time and facilities.

Tentative and Miscellaneous Definitions.

ENGINEER—One who is engaged in practicing the art or science relating to the discovery, investigation and utilization of the principles, forces, properties and substances of Nature and to the methods, means, devices, machines, apparatus and structures for employing the same.

Note: This is concise in its expression but comprehensive in its meaning and application.—Alfred W. Kiddle.

ENGINEER—One who is engaged in utilizing or in directing or instructing others in the utilization of the principles, forces, properties and substances of nature in the production, manufacture, construction, operation and use of things; or who utilizes or directs or instructs others in the utilization, production, manufacture, construction and operation of means, methods, machines, devices and structures for utilizing or employing the principles, forces, properties and substances of nature.—Alfred W. Kiddle.

ENGINEERING—Is the art or science of utilizing, directing or instructing others in the utilization of the principles, forces, properties and substances of nature in the production, manufacture, construction, operation and use of things; or of utilizing or directing or instructing others in the utilization, production, manufacture, construction and operation of means, methods, machines, devices and structures for utilizing or employing the principles, forces, properties and substances of nature.—Alfred W. Kiddle.

ENGINEER—He who practices the art or science of engineering.

ENGINEERING—The art or science governing the application of the forces and materials of nature to the use of man.—J. A. Davies.

A PROFESSIONAL ENGINEER is a man informed in the principles of engineering, and professionally engaged in the practice of engineering as hereinafter defined.

ENGINEERING is the art which applies science and scientific methods to develop and control resources of Nature for the use of Man. It involves measuring, directing of forces, controlling of processes, instructing and directing of men, and organizing of human efforts, for the fabrication of machines, the erection of structures, the production and transportation of articles of commerce, and the maintenance, operation or demolition of machines and structures. Its purpose is the advancement of the welfare of Mankind.—Alfred D. Flinn.

ENGINEERING—Definition in large letters on the wall of Engineering Societies Library, New York: "Engineering, the art of organizing and directing men and controlling forces and materials of nature, for the benefit of the human race."—Henry Gordon Stott, Presidential address, 1908, to American Institute of Electrical Engineers.

ENGINEERING—S. E. Lindsay, engineer for the Puget Sound Traction, Light & Power Co., Seattle, has recently proposed the following:

"Engineering is the practice of safe and economic application of the scientific laws governing the forces and materials of nature [illegible] for the general benefit of mankind.

An Engineer is one who is properly qualified to engage in the practice of engineering.

"If the phrase 'for the general benefit of mankind' is eliminated, Mr. Lindsay's definition is almost [illegible] to the one [illegible] given in Gillette's Handbook of Cost Data ten years ago, namely, 'Engineering is the conscious application of science to the problems of economic production.' Mr. Gillette pointed out that since management had become a science it was unnecessary specifically to mention the management of men in defining engineering. In the new Handbook of Mechanical and Electrical Engineering by Gillette and Dana, Mr. Gillette's original definition is slightly changed and it reads, 'Engineering is the systematic application of science to the problems of economic production.'"

A definition is a brief specification. A definition of engineering specifies what human activities are of an engineering nature. Most of the older engineers at first refused to revise the Tredgold definition so as to admit 'management engineers,' 'industrial engineers,' 'efficiency engineers,' 'cost analysis engineers,' and the like, to the brotherhood of technical engineers. Even yet the requirements for membership in many of the great engineering societies are so worded that if taken literally, a management engineer could not become a full member without qualifying as a designing or constructing engineer. Thus the old, narrow conception of engineering still survives in the by-laws of engineering societies, even though a modern definition 'is written in large letters on the wall of the engineers' library in New York.'"—Engineering and Contracting, October 8, 1919.

Definitions of Engineering: Committee of Development American Society of Civil Engineers, October, 1919.

(a) Engineering is the science and art of directing the great sources of power in Nature to the use and convenience of man.

(b) Engineering is an art and science. It is a science insofar as physical laws are its basis, and an art in so far as in the application of those laws the things designed and constructed develop the spirit of progress, the creation of wealth, and the well-being of all peoples.

Engineering is generally divided into four major divisions, viz., civil, mechanical, electrical and mining.

The practice of engineering requires knowledge of physical laws, forces, and the materials of Nature.

The professional engineer is one who by reason of special training, education, and experience is qualified to design and direct the construction of engineering work in one or more of the major divisions of engineering.

(c) Engineering is the creative science and art of applying economically the materials and forces of Nature to the use and convenience of man.

(d) Engineering is the science of industrial effort, and the science and art of applying this effort for the welfare of the public.

An engineer is one versed in the science and art of industrial effort made for the purpose of public welfare.

Definition of Engineering, from a Typical Law for Registration of Professional Engineers, Drafted by a Joint Committee of American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining Engineers, Society of Naval Architects and Marine Engineers, American Institute of Consulting Engineers, February, 1915.

"A person practices professional engineering within the meaning of this act who practices any branch of the profession of engineering other than military engineering. The practice of said profession embraces the design and the supervision of the construction of public and private utilities, such as railroads, bridges, highways, roads, canals, harbors, river improvements, lighthouses, wet docks, dry docks, ships, barges, dredges, cranes, floating docks and other floating property, the design and the supervision of the construction of steam engines, turbines, internal combustion engines and other mechanical structures, electrical machinery and apparatus, and of works for the development, transmission or application of power, the design and the supervision of mining operations and of processes and apparatus for carrying out such operations, and the design and the supervision of the construction of municipal works, irrigation works, water supply works, sewerage works, drainage works, industrial works, sanitary works, hydraulic works and structural works and other public or private utilities or works which require for their design or the supervision of their construction such experience and technical knowledge as are required in Section 8 of this act for admission to examination. The enumeration of any public or private utilities or works in this section shall not be construed as excluding any other public or private utilities or works which require such experience and technical knowledge for their design or the supervision of their construction. The execution as a contractor of work designed by a professional engineer or the supervision of the construction of such work as a foreman or superintendent for such a contractor shall not be deemed to be the practice of professional engineering within the meaning of this act.

Professional engineer means any person who practices professional engineering.

ENGINEER—"By the engineer I mean the man who can apply imagination to facts, the planner, the one who sees his way through, the one who deals with realities in the light of possibilities. The men who drafted the constitution of the United States were engineers. They did not attempt to do the impossible, they tried to do the best possible with the facts as they knew them. Four great pieces of legislation, such as the Federal Reserve Act, are matters of engineering just as completely as an irrigation project on which we gather into one great reservoir the waters of a score of streams and then spread these waters again over the thirsty lands by hundreds of miles of ditch. . . . More and more we will find use for the man who thinks ahead with the sure background of facts. This is statesmanship, this is engineering." Extract from letter of Hon. Franklin K. Lane, Secretary of the Interior, January 21, 1920, to John R. Dunlap, Editor and Proprietor "Industrial Management," published in February, 1920, issue of that paper.

Definitions of "Art," "Science," "Profession."

"ART—in the most extended and popular sense of the word, means everything which we distinguish from Nature. Art and Nature are the two most comprehensive genera of which the human mind has formed the conception. Under the genus Nature, or the genus Art, we include all the phenomena of the universe. . . . We designate familiarly as Nature all which exists independently of our study, forethought, and exertion—in other words, those phenomena in ourselves or the world which we do not originate but find; and we designate familiarly as Art, all which we do not find but originate—or in other words, the phenomena which we do add by study, forethought and exertion to those existing independently of us. . . . If, though, we were called upon to frame a general definition of Art leaving room for every accepted usage of the word, it would run thus: Every regulated operation or dexterity by which organized beings pursue ends which they know beforehand, together with the rules and the result of every such operation or dexterity."

"SCIENCE—consists in knowing, Art consists in doing. What I must do in order to know is Art subordinate to or concerned in Science. What I must know in order to do, is Science subordinate to or concerned in Art." Encyclopedia Britannica, 9th Edition.

PROFESSION—"A learned profession may be defined as a vocation in which scholarly accomplishments are used in the service of society, or of other individuals, for a valuable consideration. Under such a definition every new vocation in which a very considerable amount of scholarship is required for its successful prosecution, and which is placed in the service of others, must be held as a learned profession, and as engineering now demands fully as great an amount of learning, or scholarship, as any other, it has already taken a high rank among these professions, although as a learned profession it is scarcely half a century old. Engineering differs from all other learned professions, however, in this that its learning has to do only with the inanimate world, the world of dead matter and force. The materials, the laws, and the forces of Nature, and scarcely to any extent its life, are the peculiar field of the engineer. I am here using the term engineer as including the large class of modern industrial workers who make the new application of science to the needs of modern life their peculiar business and profession. A man of this class may also be called an applied scientist." Extracts from "Two Kinds of Education for Engineers," Prof. J. B. Johnson.

A PROFESSION is defined as being "a vocation founded upon specialized educational training, the purpose of which is to supply disinterested counsel and service to others, for a direct and definite compensation, wholly apart from the expectation of other business gain."

ART. Practice as guided by the correct principles in the use of means for the attainment of a desired end. (1) Skill in applying knowledge or ability to the accomplishment of a concrete purpose. (2) A system of rules devised for procuring some scientific, esthetic or practical result; also, the mastery of such rules; by extension, a branch of learning to be studied in order to be applied; as, the art of arithmetic; the seven liberal arts of the Schoolmen. (3) Facility resulting from practise; dexterity; hence, power. New Standard Dictionary, 1916 edition.

SCIENCE. 1. Knowledge gained and verified by exact observation and correct thinking, especially as methodically formulated and arranged in a rational system; also, the sum of universal knowledge.

Science in the wide sense includes (1) science proper, embracing (a) exact knowledge of facts (historical or empirical science), (b) the exact knowledge of laws obtained by correlating facts (nomological science), and (c) the exact knowledge of proximate causes (rational science), and (2) philosophy. In the narrow sense of positive science the word is used as including only the first two divisions of science proper.

2. Any department of knowledge in which the results of investigation have been worked out and systematized; an exact and systematic statement of knowledge concerning some subject or group of subjects; especially, a system of ascertained facts and principles covering and attempting to give adequate expression to a great natural group or division of knowledge; as, the sciences of astronomy, botany, chemistry and medicine.

The sciences are divisible into (1) the mathematical, treating of quantity; (2) the physical, treating of matter and its properties; (3) biological, treating of the phenomena of life; (4) the anthropological, treating of man; (5) the theological, treating of the Deity.

In the progress of human knowledge a science, in its earliest and simplest form, is usually a mere collection of observed facts, like the knowledge of the movement of the heavenly bodies possessed by the ancient Egyptians. The next step is to correlate or generalize these facts, forming a system like that of Ptolomy, or Copernicus; the next, to formulate these generalizations as laws, as was done by Kepler; the final step, to proceed to some principle or force accounting for these laws, usually by the aid of mathematical analysis, as was done by Newton in his theory of universal gravitation. The tendency of modern physical science is toward this more complete generalization, its goal being the discovery of a principle that shall connect all physical phenomena. New Standard Dictionary, 1916 edition.

PROFESSION—1. An occupation that properly involves a liberal education or its equivalent, and mental rather than manual labor; especially, one of the three so-called learned professions.

2. Hence, any calling or occupation involving special mental and other attainments or special discipline, as editing, acting, engineering, authorship, etc., also, the collective body of those following such vocation.—New Standard Dictionary, 1916 edition.

A Test of the Adequacy of Tentative Definitions.

Note: Additions should be made to the columns below, if they do not cover all branches of modern professional engineering, exclusive of military engineering.

ENGINEER—One who is engaged in:

discovering investigating developing controlling measuring conserving adapting utilizing and/or instructing others concerning	the principles forces powers properties substances elements and/or resources OF NATURE.

And/or one who is engaged in:

Inventing discovering devising investigating developing designing constructing erecting producing making operating employing practicing and/or instructing others concerning	means methods processes machines apparatus devices and/or structures	for utilizing employing controlling directing rendering available adapting transforming generating distributing and/or transmitting	the principles forces powers properties substances elements and/or resources OF NATURE

—Alfred W. Kiaale

Detailed Description of Professional, Civilian* Engineer to Include Members of All Branches of the Profession.

(Exclusive of Military Engineering.)

Note: Emendations may be made, if the following statement is not sufficient. It is intended to be used as an aid in framing definitions of "engineer" and "engineering."

A PROFESSIONAL, CIVILIAN ENGINEER is one who, being informed in the natural, mathematical and sociological sciences and the industrial arts, is engaged in:

1. Discovering and developing forces, materials and other resources of Nature.

2. Measuring forces and the properties of materials (substances).

3. Utilizing resources of Nature for the benefit and convenience of Man.

4. Inventing machines, structures, processes and devices.

5. Organizing men, equipment and facilities for construction or production or demolition.

6. Designing, constructing and/or maintaining or demolishing structures.

7. Designing, constructing and/or maintaining or demolishing machines of all kinds, and/or directing their operation.

8. Designing, constructing and/or maintaining or demolishing ways and means of communication, transportation, illumination, heating and ventilation, and/or facilities therefor, and/or directing their operation.

9. Designing and constructing vehicles, vessels and other means for transporting persons and/or goods on, in, through, over, under land, water, air.

10. Investigating properties, projects, prospects and routes.

11. Investigating methods, efficiency and economy of construction, production and/or operation.

12. Surveying land, bodies of water, mines, structures, and quantities of materials, incidentally to other functions of professional practice.

13. Excavating, embanking, grading, tunneling.

14. Inspecting and testing materials, [illegible] processes, machines and structures.

15. Generating and/or transmitting [illegible] and intelligence.

*Used with the early broad meaning [illegible] the opposite of "military."

16. Regulating, surveying, conserving [illegible] water and other natural resources.

17. Regulating streams for prevention [illegible] of navigation.

18. Designing, constructing, maintaining [illegible] harbors, harbor works, channels, canals, [illegible] to navigation.

19. Reclaiming waste lands by drainage [illegible] methods of improvement.

20. Supplying communities and industries [illegible]

21. Draining or sewering cities, towns or [illegible]

22. Disposing of sewage and other wastes.

23. Demolishing structures and machines.

24. Developing and improving forests, parks [illegible] private grounds.

25. Preparing plans, specifications, contracts [illegible] other documents for purposes of construction [illegible] demolition.

26. And/or directing, instructing, supervising [illegible] the above functions.

27. And/or giving advice in regard to any of said [illegible]

28. And/or directing, instructing, supervising, or superintending those performing the skilled or unskilled labor inv[illegible] engineering operations.

29. In the foregoing paragraphs, "construction" is [illegible] include assembling, erection, re-construction, alteration, [illegible] ment and repair.

30. With all the machines and structures mentioned above [illegible] included their appurtenances.

31. In all the functions of the professional engineer the mental elements predominate, including the ability to originate, adapt, analyze and apply; in contradistinction to the functions of the mechanician, technician, constructor, computer, craftsmen or operative, in which predominate physical or mental skill gained by instruction and repetition.

Some Designations of Modern Engineering Specialties.

Aeronautical Engineering
Agricultural Engineering
Automotive Engineering
Bridge Engineering
Cadastral Engineering
Cartographic Engineering
Ceramic Engineering
Chemical Engineering
Civil Engineering
Commercial Engineering
Consulting Engineering
Drainage Engineering
Efficiency Engineering
Electrical Engineering
Electric Railway Engineering
Electrochemical Engineering
Experimental Engineering
Fire Prevention Engineering
Forestry Engineering
Gas Engineering
Harbor Engineering
Heating and Ventilating Engineering
Highway Engineering
Human Engineering
Hydraulic Engineering
Hydrographic and Geodetic Engineering
Illuminating Engineering
Industrial Engineering
Irrigation Engineering
Landscape Engineering
Management Engineering
Marine Engineering
Materials Engineering
Mechanical Engineering
Metallurgical Engineering
Military Engineering
Mill Engineering
Mining Engineering
Municipal Engineering
Nautical Engineering
Naval Architecture or Engineering
Ordnance Engineering
Petroleum Engineering
Power Engineering
Radio Engineering
Railroad Engineering
Rapid Transit Engineering
Refrigeration Engineering
Research Engineering
Safety Engineering
Sanitary Engineering
Signal Engineering
Structural Engineering
Telephone Engineering
Topographic Engineering
Valuation Engineering
Water Supply Engineering

Historical Notes on "Engineer" and "Architect."

Historically the builders of fortifications, the military engineer and the builder of dwellings and temples, the architect, were earliest on the ground. The distinction was then between soldier and architect, not between Engineer and Architect. All of us who have translated him, remember that Julius Caesar built a bridge, and we know of the military Roman roads of England. In his illuminating lecture on "The Roman [illegible] Engineering," Professor C. J. Tilden, of Yale, shows that Vitruvius in his treatise written about the beginning of the Christian Era divides the field of architecture into three main divisions as follows:

1. The Art of Building—(a) The construction of fortified towns and of works for general use in public places—I. For defensive purposes—the planning of walls, towers and gates, permanent devices for resistance against hostile attacks. II. For religious purposes—the erection of fanes and temples to the immortal gods. III. For utilitarian purposes—the provision of meeting places for public use, such as harbors, markets, colonnades, baths, theaters, promenades, and all similar arrangements. (b) The putting up of structures for private individuals.

2. The Making of Time-pieces. (Sun dials, water clocks, etc.)

3. The Construction of Machinery—(a) Civil—water wheels, screw pumps, hodometers, etc. (b) Military—Ballistae, catapults, rams, siege machines, etc.

The very considerable Avignon bridge across the Rhone River [illegible] sixty-five to ninety ft. [illegible] to the piers was regarded [illegible] Architect of [illegible] was not only the Architect of St. [illegible] matters of [illegible]

Leonardo da Vinci [illegible] Cathedral and painted the "Last Supper" [illegible] he was a Chief Military Engineer [illegible] designs with irrigation [illegible] signed a flight of six [illegible] He [illegible] as well as architect.

The term Architect in its etymology means Master Builder.

In the evolution of construction [illegible] by some vagary of word-growth been [illegible] apart and their kinship sometimes questioned. It is only that in the juggling of old terms and the emergence of new terms one class of engineers and a class whose work is of the [illegible] specialized technical kind which deals with the direction of great mechanical forces has kept the old family name, the Naval Architects. An accident of name-evolution has tended to separate one class of master-builders from the other class of master-builders. It may be thought that initiative and imagination are the qualities of Architects while Engineers deal with the prose of construction. Analysis will, however, reveal the fact that eighty per cent of the architectural structures of our cities are commonplace with no peculiar beauty or originality. Now and again a Woolworth building springs sky-ward, worthy of the phrase "frozen music," and we recognize again the master-builder of the sixteenth century. But the same quality of mind went into the wireless telegraph, the airplane, the Panama canal and great electric developments and transmission at Niagara. Engineers without creative imagination are as mediocre as Architects without this same vital and indispensable attribute of the master-builder. Architects must recognize that scientific imagination is on the same high plane as their own best creative thought, and Engineers must concede the esthetic contribution of Architects in adding to the durable satisfactions of life. Both are creative workers.—Francis C. Shenehon, M. Am. Soc. C. E.

Definitions of "Engineer" and "Engineering" as Written into State License Laws.

Note.—Eleven States have laws regulating the practice of engineering.

A person shall be regarded as practicing **structural engineering** within the meaning of this act who is engaged in the designing or supervising of the construction, enlargement or alteration of structures, or any part thereof, for others, to be constructed by persons other than himself. Structures within the meaning of this act are all structures having as essential features, foundations, columns, girders, trusses, arches and beams, with or without other parts, and in which safe design and construction require that loads and stresses must be computed and the size and strength of parts determined by mathematical calculations based upon scientific principles and engineering data. A person shall also be regarded as practicing structural engineering within the meaning of this act who is engaged as a principal in the designing and supervision of the construction of structures or of the structural part of edifices designed solely for the generation of electricity, or for the hoisting, cleaning, sizing or storing of coal, cement, sand, grain, gravel or similar materials, elevators, manufacturing plants, docks, bridges, blast furnaces; rolling mills, gas producers and reservoirs, smelters, dams, reservoirs, waterworks, sanitary works as applied to the purification of water, plants for waste and sewage disposal, round houses for locomotives, railroad shops; pumping or power stations for drainage districts, or power houses, even though such structures may come within the definition of "buildings" as defined in any act in force in this state relating to the regulation of the practice of architecture.—Illinois Law, 1920.

Civil Engineering, within the meaning of this act, is the practice of any branch of the profession of engineering other than mining, metallurgical and military. Said profession embraces the design and supervision of the construction of all public or private utilities except those in connection with mining operations exclusively, and other works which require experience, and the same technical knowledge as engineering schools of recognized reputation prescribe for graduation.—Idaho Law, 1919.

An Engineer, within the meaning of this act, is a person who is engaged in the practice of the profession of engineering in any of its branches, except military engineering.—Colorado Law, 1919.

Joint Committee Definition of 1915 was written into Florida Law, 1917, Oregon Law, 1919, and Iowa Law, 1919. Florida Law omits sentence: "The enumeration of any public or private utilities or works in this section shall not be construed as excluding any other public or private utilities or works which require such experience and technical knowledge for their design or the supervision of their construction." Iowa Law omits the same sentence and inserts after the words "such a contractor," "or the construction, improving, or extending of private drains or drainage works, private irrigation works, private water supply works or other works of a private nature shall not be deemed to be the [illegible] of [illegible] engineering w[illegible] [illegible] [illegible]

Louisiana, Michigan, New York, Virginia and W[illegible] [illegible] laws [illegible]

Definitions from Catalogs of American Universities and Engineering Schools.

Engineering Courses and Subjects

It would seem [illegible] satisfactory [illegible] engineering [illegible] however [illegible] or long [illegible] comprehensive enough [illegible] subjects in [illegible] courses [illegible] or in other [illegible] engineering [illegible] embrace the [illegible] of [illegible] engineering [illegible] engineering [illegible] the following statements [illegible] extracted.

Harvard Engineering School. Departments of study are Mechanical Engineer, Electrical Engineer, Civil Engineer, Sanitary Engineer, Mining Engineer, Metallurgical [illegible] Industrial Chemist [illegible] Mining, Metallurgy and Chemistry [illegible] in several [illegible] with [illegible] and such phrases [illegible] Mining Engineer and Metallurgical Engineer. The curriculum [illegible] also Heat Engineering, Factory Management, [illegible] Power Engineer, Railroad Engineer, Highway Engineer and Chemical Engineer.

[illegible] subjects covered in the science of construction are:

Mathematics
Physics
Mechanics
Surveying
Machine design
Materials of engineering
Chemistry
Industrial chemistry
Physical chemistry
Gas analysis
Chemical engineering
Heat engineering
Power and industrial plants
Internal-combustion motors
Mechanical refrigeration
Thermodynamics
Hydraulics
Water-power engineering
Turbines and centrifugal machinery
Water-works design
Sewerage design
Meteorology
Sanitary engineering
Bacteriology
Biology
Water purification and sewage treatment
Water and sewage works
Vital statistics
Railroad engineering
Highway engineering
Roads and pavements
Transportation
Electricity
Electrical engineering
Dynamo design
Electrical transmission and distribution of power
Electric railway engineering
Industrial application of electric power
Telegraphy and telephony
Radio engineering
Illumination and photometry
Accounting
Business administration
Factory management
Valuation of public service and other corporations
Geology
Mineralogy
Geology of ore deposits
Petrography
Theory of structures
Design of roofs and bridges
Reinforced concrete
Structures of metal, wood and masonry.
Coal mining
Metal mining
Mining plant
Mine surveying
Mining projects and design
Mine examination and reports
Economics of mining
Ore dressing
Treatment of ore
Leaching processes
Fire assaying
Metallurgy of iron and steel
Metallurgy of non-ferrous metals
Metallurgical chemistry
Metallurgical construction
Metallurgical projects and design
Metallurgy and physics of metals
Metallic alloys

Massachusetts Institute of Technology. Architecture and Architectural Engineering. Biology and Public Health, with options in Bacteriology and Industrial Microbiology, and in Sanitary Biology and Public Health; Chemistry, Chemical Engineering; Civil Engineering, with options in Hydraulic Engineering, Railroad Engineering, Highway Engineering and Military Engineering; Electrical Engineering; Electrochemical Engineering; Engineering Administration, General Science, Geology and Geological Engineering, Mechanical Engineering, Mining Engineering and Metallurgy, Naval Architecture, (In this department graduate [illegible] in aeronautical engineering is given); Physics, with options in Industrial and Theoretical Physics, Sanitary Engineering.

Civil engineering is the broadest in scope of the engineering professions, being the parent stem from which have diverged all the other branches; but, even though these have become recognized as distinct professions, the field of civil engineering still remains so large that no one can become expert in its whole extent. [illegible] topographical engineering; the building of railroads, [illegible] and other works serving the purposes of [illegible] transportation; municipal engineering, including the construction of sewers, waterworks, roads and streets, structural engineering, including the construction of bridges, buildings, walls, [illegible] and all fixed structures; hydraulics, the [illegible] and other branches.

[illegible] Engineering [illegible] embraces outdoor engineering [illegible] developed branch of the profession [illegible] ranks next in point of time [illegible] of all industrial progress. It is [illegible] production in Industry.

The [illegible] Engineering provides [illegible] of designing and [illegible] properties requisite [illegible] to furnish a well [illegible] ship-builders, ship-designers, ship-managers, or marine engine builders, or who desire to enter allied industries

Columbia University.

Mining Engineering—The three-year course leading to the degree of Engineer of Mines is intended to train men for work leading to the development of mineral properties and the design and construction of mine plants, and management of mines. The course is necessarily broad, comprising a wide range of studies in pure and applied science.

Metallurgical Engineering The primary aim of the course leading to the degree of Metallurgical Engineer is to train students for laboratory, operative, or administrative positions in metallurgical works.

Civil Engineering The three-year course leading to the degree of Civil Engineer is designed to afford as broad a training in the various fields of Civil Engineering as is consistent with the requirements for thorough instruction Students are required to pursue a course of studies covering not only those subjects offered by the Department of Civil Engineering, but also those matters relating to the development and use of power offered by the departments of Electrical and Mechanical Engineering. Courses in the departments of Mathematics, Mechanics and Physics form the basis for the theoretical portion of the instruction and the results obtained are applied to practical engineering work.

The course in **Structural Engineering** deals with the graphical and analytical treatment of engineering structures such as retaining walls, dams, bridges, buildings, arches.

Hydraulic Engineering treats specifically of water supply for cities and towns, water power, irrigation and canals and the details of design, construction and management for works of these types, as well as the improvement of rivers and harbors, and the subject of drainage.

The theoretical and practical work in **Railroad Engineering** is of such a character as to make the courses in this field exceptionally complete; an especially thorough treatment of the economics of location and operation, freight yards and terminal facilities, block signals and interlocking, and railroad structures.

Special provision is made for graduate work in **Highway Engineering** and allied subjects, designed particularly for men who intend to follow the practice of Highway Engineering.

Sanitary Engineering—The three-year graduate course aims to include the subjects given in the Civil Engineering course necessary for the sanitary engineer and provides a working knowledge of sanitary science and the sanitary arts. The sanitary engineer must not only be able to design and construct water purification plants and sewage disposal systems, but he must understand the chemical and biological processes upon which the successful operation of these plants is based. He must not only be able to construct such engineering features as will prevent epidemics and further the health and comfort of individuals and communities, but he must have a knowledge of bacteriology, sanitary statistics, and the sources and modes of infection.

Electrical Engineering—The prescribed course leading to the degree of Electrical Engineer comprises the important branches of theoretical and applied electricity, also the fundamental and collateral subjects, which have been found by experience to be required by the electrical engineer as, for example, physics, chemistry, mechanical engineering, including boilers, gas producers, engines, turbines, hydraulic developments, transmission devices and shop work, also such general engineering subjects as construction in wood, masonry, iron and steel.

Mechanical Engineering—The regular three-year course, leading to the degree of Mechanical Engineer, offers a thorough basio training in the design, construction, manufacture, and operation of all classes of standard and special machinery, and their economic application to railroads, ships mills, shops, factories, and power plants, as well as in the technical and executive management of the manufacturing and transportation industries.

Chemical Engineering The courses leading to the degree in Chemical Engineering are carefully chosen with a view to training men to develop and direct those industrial and manufacturing operations and processes which are based upon the application of chemistry. The students have the advantage of obtaining Civil Engineering courses in Hydraulics and Resistance of Materials. Electrical applications are studied in the Direct and Alternating Current Laboratories with the electrical engineers. A study of steam and gas power machinery, pumps, turbines, blowers and hydraulic equipment in the mechanical engineering laboratories supplements the courses in general physics, thermodynamics and hydraulics.

Cornell University The work of the student comprises an extended course in mathematics, mechanics and graphics, and their applications to engineering The object aimed at is to give as thorough a preparation as possible for the general purposes of the profession in the following subjects: the survey, location, and construction of roads, railroads, canals, and water works; the construction of foundations under water and on land, and of superstructures and tunnels; the survey, improvement, and protection of coasts, and the regulation of rivers, harbors, and lakes the astronomical determination of geographical coordinates for geodetic and other purposes; the application of mechanics, graphical statics and [illegible] [illegible] geometry to the construction of the various kinds of [illegible] [illegible] roofs, trusses, suspension and cantilever bridges; [illegible] [illegible] districts, sewerage of towns and the irrigation and [illegible] of land; the design, construction, application [illegible] [illegible] [illegible] and electric motors and steam engines; the [illegible] of drawings, plans and specifications, and the [illegible] [illegible] and tests of the materials used in construction. [illegible] [illegible] is given in [illegible] [illegible] [illegible] and jurisprudence [illegible] [illegible] dealt [illegible] in an elementary manner with [illegible] [illegible] of contracts and [illegible] and the ordinary [illegible] [illegible] the laws of [illegible] and riparian rights.

Mechanical Engineering underlies [illegible] [illegible] of the [illegible]. Its province includes the design, construction, operation and testing of steam engines, steam [illegible], [illegible] and power plants, [illegible], gas and oil engines, [illegible] [illegible] [illegible] machinery, pumping engines, [illegible] [illegible] air machinery, ice-making and refrigerating [illegible], [illegible] equipment for heating and ventilation, machine [illegible] [illegible] equipment and transmission machinery. The work of [illegible] [illegible] engineer includes the planning of power plants and [illegible] [illegible] the selection and installation of their equipment [illegible] [illegible] of the systems of operation and of manufacturing processes and the organization and administration of [illegible].

Electrical Engineering includes the design, construction, operation and testing of electrical equipment used for the generation, [illegible] and utilization of electrical energy.

University of Illinois, College of Engineering—The [illegible] [illegible] provides instruction in twelve four-year curricula in the following branches of engineering:

Architecture
Architectural Engineering
Ceramic Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering
Mining Engineering
Municipal and Sanitary Engineering
General Engineering Physics
Railway Civil Engineering
Railway Electrical Engineering
Railway Mechanical Engineering

University of Michigan, College of Engineering—The broad [illegible] of Engineering includes the discovery, conservation and [illegible] of the resources of the earth, the waters and the air. [illegible] [illegible] not only the exploration of mineral, timber and other [illegible] resources of the world, but also the experimental investigation of the laws controlling important phenomena and processes. Conservation includes the prevention of waste of all sorts, whether of natural resources or in manufacturing processes. Utilization includes the generation and transmission as well as the actual application of heat, light and electricity [illegible] mechanical, electrical and chemical means to serve [illegible] [illegible], the design and erection of structures and machinery [illegible] [illegible] and the efficient operation of all processes, involving [illegible], manufacture, transportation or utilization of materials on a large scale. In the newer conception of Engineering [illegible] [illegible] must consider not only the physical property but also the relation of the industry to the outside world, [illegible] its duty to stockholders, employees, clients and the community in which it is situated.

Civil Engineering is the oldest and best known of the engineering [illegible]. It deals especially with the design of static [illegible] structures and is divided into several groups:

Structural Engineering, which deals with problems of design and construction in steel for bridges, roofs and buildings, masonry [illegible] and plain and reinforced concrete.

Hydraulic Engineering, which takes up the problems of [illegible] [illegible], water power development, rivers and harbors, and [illegible] [illegible] the measurement of water and design and construction of dams, locks, wharves, irrigation works and [illegible] other [illegible] of hydraulic construction.

Transportation Engineering, which deals with railroads and other forms of transportation, the location, construction, [illegible] [illegible] operation and also the history and economics of [illegible] [illegible] [illegible].

Sanitary Engineering, which deals with the design and [illegible] of water works, sewerage, water purification, [illegible] [illegible] [illegible] [illegible] and with all matters related to [illegible] [illegible]. It offers many opportunities for advanced work and research along the line of prevention of disease by the [illegible] construction and operation of engineering structures.

Municipal Engineering, which deals with the design, construction and maintenance of paving, sewers, sidewalks, street drainage, waterworks and other municipal public works, the laws controlling their construction and operation, the proper design and laying out of cities and villages, and the construction and regulation of street railways and other utilities.

Highway Engineering, which deals with the design and construction of roads and pavements, the chemical and physical properties of construction materials and the testing of stone, brick, oil, asphalt and other materials used in road building.

Mechanical Engineering is the branch of engineering which deals with the problems of the manufacturer. Mechanical Engineering naturally divides itself into the following groups:

Steam Power Engineering deals with the design, construction and operation of the various forms of prime movers using steam [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

Internal Combustion Engineering [illegible] [illegible] [illegible] the gas and [illegible] [illegible] [illegible] [illegible] [illegible]. It [illegible] the design, construction and [illegible] [illegible] [illegible] [illegible] internal combustion [illegible] [illegible] [illegible] [illegible] of [illegible] products.

Hydro-Mechanical Engineering [illegible] [illegible] the design, construction and installation of the [illegible] [illegible] [illegible] water [illegible] [illegible] water turbines.

Heating, Ventilating and [illegible] [illegible] [illegible] deals with the theory, design and [illegible] of heating, ventilating and refrigerating plants. Special [illegible] [illegible] [illegible] applications of heating and ventilation to [illegible] [illegible].

Automobile Engineering covers the [illegible] [illegible] of [illegible] [illegible] the theory and design of [illegible] [illegible] [illegible] [illegible] units and laboratory and [illegible] [illegible] [illegible] the [illegible] [illegible] parts of the automobile or of the [illegible] [illegible] itself.

Industrial Engineering is provided for those who wish to prepare for the business side of the manufacturing plant or who wish to follow the profession of production engineers.

Electrical Engineering is subdivided as follows:

Electric Power Engineering deals with the theoretical and practical phases of power generation, distribution and utilization, together with the design and construction features of the apparatus applicable thereto and [illegible] [illegible] applications [illegible] [illegible] in its relations to electric railways, lighting, power plants, [illegible] and motors and the service of the public in its economic and ethical aspects.

Electrical Communication, dealing with the transmission of [illegible] and of speech by electrical means with and without wires, is the oldest branch of electrical engineering and includes telephony, telegraphy, electric signalling and radio communication.

Illumination Engineering deals with the many and varied specific problems arising in relation to the production and utilization of light economically and in accordance with correct principles of [illegible], physiology, psychology, art and architecture.

Chemical Engineering treats of the operation and control of [illegible] important industrial operations in which chemical processes [illegible] [illegible] part. All metallurgical operations which involve melting or even heat treatment of metals, the manufacture of hydraulic cements, clay products and glass, the acid and alkali industries, electrometallurgy, all processes connected with the utilization of fuel by combustion or destructive distillation to form gas, coke and tar, the processes of water purification, the refining of the fats and oils and their manufacture into soap, paint and varnish, the manufacture of sugar, paper pulp and paper, and explosives, the bleaching and dyeing of cotton, wool and silk are illustrations of the large industries which involve chemical engineering.

Marine Engineering embraces the design, construction and operation of ships and other floating structures and the machinery appertaining thereto and to the auxiliary construction of [illegible] and wharves.

Aeronautical Engineering embraces the general theory of aerodynamics, the design and construction of airplanes, balloons, etc., and questions relating to engines and propellers for air craft.

Stevens Institute of Technology—The term mechanical engineering is used in its broadest sense to include instruction in Electrical, Civil and other branches of Engineering.

Princeton University—Course in Civil Engineering. Subjects included are:

Mathematics
Physics
Chemistry
Engineering drawing
Surveying
Mathematics and mechanics
Economics
Mechanics of materials
Machine design
Electrical engineering
Heat engines
Geodesy
Railway engineering
Structures
Hydraulics
Water power
Concrete constructions
Railway economics
Municipal engineering
Water supply
Sewerage
Gas engines

Rensselaer Polytechnic Institute—Civil Engineering—Instruction is given in the design, location and construction and superintendence of public works such as railways, canals, water works, sewerage systems; the design, construction and management of [illegible] iron works, steel works, hydraulic plants, electric plants, chemical works; the design and construction of buildings, roofs, arch bridges of stone, concrete and steel, girder and truss bridges, cantilever, draw and suspension bridges; the design, construction and use of wind motors, hydraulic motors, electric motors, gas engines and various kinds of steam engines; the design, construction and use of machinery in general and the determination of their efficiency; the selection and test of materials used in construction; the metallurgy of iron and steel; mineralogy and geology; the determination of latitude, longitude and time; and the survey of mines and of rivers, [illegible] and harbors, and the direction of their improvement.

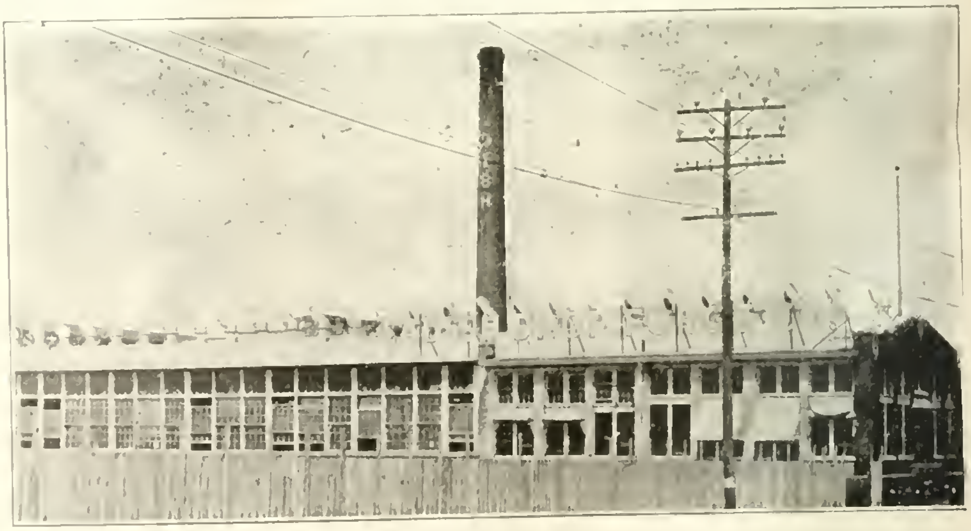
Mechanical Engineering—The course prepares the student for the construction and operation of power plants and plants for manufacturing purposes; the design and construction of steam engines, steam turbines, boilers, gas engines, automobiles, aero-

[illegible], engineering structures, marine engines, ships, hydraulic installations, hydraulic motors and pumps, the management and operation of electric machinery for direct and alternating current, transmission and distribution of electricity, the methods of transmitting and transforming motion of various kinds, the care and management of shops as well as the methods of shop practice, the use of surveying instruments and making of surveys; the construction of mechanical drawings for [illegible] and framed structures, the use of gears, the metallurgy of iron and steel, the design of heating systems and refrigerating plants, the determination of efficiency of heat engines and other machines; the [illegible], care and test of various forms of apparatus, materials and machines, the methods of making engineering investigations and the general methods of conducting engineering operations, including the writing of specifications and contracts, the making of estimates, the keeping of costs and the management of men.

Electrical Engineering. The design, operation, testing and application of direct and alternating current machines including generators, motors, frequency changers, rotary converters, transformers, switchboards, and other appliances, the design, construction, equipment and complete tests of all classes of power plants, including hydraulic power developments; the design and overhead systems for the transmission of underground and overhead systems for the transmission of electrical energy and its distribution for light, heat and power purposes, electric railway systems including their layout, roadbed, track and line construction, car equipment and signal systems, the application of arc and incandescent lamps to interior lighting systems, telephone and telegraph systems including switchboard and line construction, storage batteries; application of electricity to chemical processes, the selection and use of the various materials used in electrical engineering; the preparation of specifications, bills of material and contracts; the operation of electric light and traction companies, including the determination of operating costs and the establishment of rates and schedules.

Ventilation System for Foundry

Engineers and contractors are often called upon to include ventilation in their building plans and in such case care should be taken to provide ventilators that have the requisite pulling capacity to thoroughly ventilate under the specific conditions which obtain in that particular factory, foundry, or whatever it may be. In some instances it is necessary to install fans which work in conjunction with the roof ventilators in forcing a prompt carrying off of offensive smoke, gas or acidous fumes. The building may need few or many ventilators. It may require ventilating flues connecting with the vents, and fans to lift the lower strata of heavy air, giving the fresh air and vitalizing oxygen a chance to get to the workmen. It makes a difference whether the roof is flat, of saw-tooth construction or plain gable of various pitch. The vital point is to get the requisite number of ventilators installed in a position where they will do the most good considering the interior conditions—number of men employed, amount of smoke and gas fumes to be taken care of.



Alpina Ventilator Installation in Foundry of Ladish Drop Forge Co., Cudahy, Wis.

An interesting example of ventilation installation is illustrated in the accompanying view of the foundry of the Ladish Drop Forge Co., of Cudahy, Wis. The building on which the ventilators are shown was constructed by Klug & Smith, contracting engineers, Milwaukee, Wis., who also installed the ventilators. In the old building, where furnaces were formerly located, the air was so dense with gas and smoke that employes were working under the greatest difficulties. The ventilators were installed before the building was completed and from the time the furnaces were started the smoke and gas fumes were quickly carried off and the building kept clear and the men are now working under conditions which meet the approval of the Wisconsin State Industrial Commission.

Fabricating Shops' Contracts. The record of the Bridge Builders & Structural Society, from reports collected by its secretary, shows that during the month of June, 1920, 90,400 tons of fabricated structural steel were contracted for throughout the United States, equivalent to 50 per cent of the entire capacity of the bridge and structural shops of the country. During the first six months of 1920, the total tonnage contracted for was 779,200 tons, equivalent to 72 per cent of capacity.

Personals

James A. McVittie, formerly city auditor of Richmond, Calif., has been appointed city manager.

Frank E. Phelps, Joseph E. Evans and C. R. Hollingsworth have organized the Phelps Construction Co., of Ogden, Utah, and will engage in a general engineering contracting business.

Ernest R. Erickson has resigned his position as civil engineer with the Minnesota Steel Company at Morgan Park to engage in a general practice of civil engineering with offices at Duluth, Minn.

Frank B. Jamison of Atlanta, Ga., William D. Hallowell of Montgomery, Ala., and David W. W. Fuller of Montgomery, have organized the Jamison-Hallowell Construction Co. of Montgomery and will engage in a general contracting business.

Prof. S. C. Shipley, for 13 years associated with the University of Minnesota engineering department, has announced his acceptance of a professorship at Roberts College, Constantinople, Turkey. Prof. Shipley, who has been in charge of the mechanical engineering shops at the university, will take charge of the shops at Roberts College. He and his family will leave Minneapolis Aug. 1, sailing for Turkey on Aug. 11.

Industrial Notes

The National Pressed Steel Co., of Massillon, O., makers of steel lumber sections and standard strip steel, have announced the opening of the following district offices: Baltimore, Md., 504 Lexington bldg., Beverley W. Blake, district manager; Boston, Mass., 201 Devonshire St., Walter M. Jackson, district manager.

R. C. Trig, formerly with the Berger Mfg. Co., of Canton, O., has associated himself with the National Pressed Steel Co., of Massillon, O., as chief engineer of the sales promotion department. Mr. Trig has been associated with the development of steel lumber sections since they were first introduced to the building industry.

The Parker Motor Truck Co., Milwaukee, Wis., announce the closing of a contract with the Wilson & Vevera Corporation, 1482 Broadway, New York City, involving the distribution of 2,000 trucks. The Wilson & Vevera Corporation are jobbers and will represent the Parker line in eight Eastern States. Dealers will immediately be established in principal cities, and truck deliveries will start Aug. 1.

The Parsons Co., manufacturers of trench excavating machinery, with main offices and works at Newton, Iowa, has opened a completely equipped branch office in Suite 1211 Lumber Exchange Bldg., 11 South La Salle St. Chicago, Ill. The Chicago territory includes at the present, the entire states of Michigan, Illinois, Indiana and Ohio, and the eastern section of Missouri. The office is in charge of Mr. James McElroy, central district sales manager.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Hammers.—David Maypolis Hammer Co., Norwich, N. Y. 68 page vest pocket size catalog of the principal varieties of hammers made by this company. Also contains tabular matter and information of interest.

Brass.—Bridgeport Brass Co, Bridgeport, Conn. A 78 page brochure giving a brief history of the ancient art of brass making and its early method of production, and contrasting these with the electric furnace process.

Storage Plants for Sand, Gravel, Etc.—Weller Manufacturing Co., Chicago. 32 page bulletin devoted to Weller storage plants and equipment for storage and unloading sand, gravel, cement, etc. Contains illustrations of interesting installations on construction jobs.

Derricks, Hoists, Etc.—Dobbie Foundry & Machine Co., Niagara Falls, N. Y. 176 page catalog illustrating and describing steel and wood derricks and derrick parts, electric hoists, steam hoisting engines, shears and shears blocks, motor plows, horse and hand power hoisting equipment, etc.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

Halbert P. Gillette, *President and Editor* Lewis S. Louer, *Vice-President and General Manager*
New York [illegible] Woolworth Bldg., Richard E. Brown, *Eastern Manager*
Cleveland [illegible] 413 Engineers' Bldg., Leo Ehlbert, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., AUGUST 4, 1920. Number 5

The Reason for California's Curtailment of Road Work

The state of California has greatly curtailed its road building, mainly because of inability to sell its $4\frac{1}{2}$ per cent highway bonds at par, but partly, we judge, for other reasons. The richer counties in the state might purchase highway bonds in sufficient amounts to permit the building of their allotment of improved road mileage. But before half the total mileage originally contemplated under the $20,000,000 appropriation had been built, the entire appropriation would be exhausted, for road costs have doubled since that appropriation was made. The result would probably be that the poorer counties would get little or none of the appropriation, and might not be able to get the richer counties to vote with them for an additional appropriation.

If this is the condition it is well that road construction has been curtailed in California until there can be a referendum vote taken on the question of raising the bond interest rate.

The opinion is expressed by "Motor Land" that "on the whole it does not appear to be bad judgment to reduce the amount of highway construction (in California) for the present until conditions improve as to cost of labor and material." With this conclusion we do not agree.

Men who have studied prices and price changes most carefully are practically unanimous in the belief that construction material prices will not recede greatly, if at all, for many years, and that construction wages will rise. If confidence is to be placed in economic experts, no plan of general construction curtailment is justifiable on the ground that construction costs will recede with sufficient rapidity to warrant waiting.

We realize that bidding prices on construction have frequently been extremely high, perhaps unreasonably high at times. When this occurs it behooves the engineers to confer with the contractors in order to ascertain whether specifications and contracts may not be so amended as to reduce the risk assumed by contractors. Time limit clauses are particularly in need of modification as a rule. Wherever practicable changes in wage and price levels should be provided for in the contract, so as to relieve the contractor of the risk incident to unforeseen rises in prices and wages.

The Outlook for Improved Freight Conditions

If resourcefulness and courage are allowed to master precedent and timidity, there should be no further curtailment of road improvement in America, except such curtailment as is necessary because of lack of freight cars or of laborers. We look to see rapid improvement in respect to car supply. By the aggressive action that railways are taking to keep all cars moving, particularly open top cars, it will be easily possible, as Daniel Willard has pointed out, to increase freight car mileage from the 2[illegible] mile daily average of the year 1919 to the 27 mile average of 1916. Mr. Willard goes further and says that a 30 mile daily average is within easy attainment. Being president of one of our great railway systems, the B. & O., he probably knows what can be accomplished.

Car mileage for the past three months has been below normal, perhaps not more than 20 miles per car day. Even a [illegible] per cent increase will be extremely helpful.

The fact that the railway unions are apparently satisfied with the increased wages that have just been awarded to them should not be overlooked in this connection. Satisfied workmen unquestionably do better work, and after all, the efficiency of the railways depends largely upon the degree of content of the 2,000,000 railway employes.

After Sept. 1 the Government will cease to guarantee the net earnings of the railways, and that in itself will stimulate railway managers to operate as efficiently as possible.

The Interstate Commerce Commission has just granted increases in freight and passenger rates, thus encouraging railway operators and owners to increase transportation efficiency.

All in all, the outlook for improved transportation is excellent.

Learned Ignorance

The recent enormous rise in commodity prices and the consequent struggles to secure corresponding increases in income have resulted in an unusual amount of discussion about economic principles. Nearly every professional writer and many a man who has never before written for publication, has had his say on one or all phases of the subject. It would be comical were it not so serious, to observe the assurance with which nearly all editors, for example, discuss the subject of price changes. Theirs is commonly the assurance that springs less from deep knowledge than from belief in their ability to solve almost any economic problems off hand, a belief that is born of the prevalent conceit of the average "educated man." As an example of this learned ignorance we quote the following from a recent editorial in a technical periodical:

> Economic laws are not reducible to mathematical formulas, for the human element enters, particularly as to the length of time involved in the economic results working out. For instance, just now the people or a majority of the people, are charged with "extravagance," but economics cannot work out a formula showing how many months will be required for the people to mend their ways.

"Economic laws are not reducible to mathematical formulas," we are told. Not all the laws of any science are expressible as formulas, but there is no science that does not have some definitely quantitative laws, and therefore laws that are expressible as formulas. Yet the editor who wrote the above quoted paragraph wrote it as part of a long discussion of present economic conditions, unaware that his very effort to show his wisdom could readily be used to prove his ignorance.

There is, of course, one redeeming feature about such displays of ignorance on the part of so-called educated men. It is perhaps better that they express erroneous opinions than to express none at all as to the causes of high prices and the like; for ultimately they are apt to learn the true causes of effects that arouse their interest. Yet, is it not rather disquieting to observe the cocksureness of non-specialists about subjects that require prolonged special study? Does it not indicate a fundamental defect in our educational methods when most "educated" men are so little given either to long study of any economic problem or to respect for the opinions of those who have devoted much time to the matter? Have not our college professors laid too much stress upon the ability of a college graduate to "think for himself," and too little stress upon the fact that no man is apt to think correctly until he has thought long and hard? Is there not, also, a prevalent belief that merely to know the methods of logic is to possess a logically trained mind?

The fact is that knowledge of the methods and principles of a science gives no complete command of that science, until there is added thereto a training sufficiently long to habituate the reasoner to use those methods and principles almost intuitively. It is the general lack of adequate training that accounts for most of the errors of "educated" men. This is often disclosed by the celerity with which they acknowledge an error. When this is so, their error is clearly the result of lack of skill in reasoning and not of lack of knowledge of how to reason.

Listen attentively to the conversation of almost any man on a subject in which he has not specialized and you will ordinarily not listen long before you hear a generalization that is not true because it is too broad. Thus you may hear it said that, "Great inventions are always very simple." Simple is the opposite of complex, yet who would not undertake to prove by example that there are at least a few great inventions that are complex? The fact is that there are many. But a man untrained in reasoning by induction often does not take the time even to review in memory all the inventions of which he has knowledge, so, reasoning from a few great inventions that are simple, he falsely generalizes that all great inventions are simple. It was this sort of careless thinking that led the editor above quoted to say that "Economic laws are not reducible to mathematical formulas."

Lessons from Engineering Council for the New Federation*

Two questions which are bound to enter the mind of any engineer considering the pros and cons of the Federated American Engineering Societies are these: "If Engineering Council is a success, why should the proposed Federation supplant it? On the other hand, if Engineering Council is a failure, why should the Federation be organized along lines so nearly parallel?" Undoubtedly these thoughts were in the minds of many delegates to the organizing conference held last month in Washington, even if they were not directly stated on the floor, for at least three very influential delegates spoke in defense of Engineering Council, denying its ineffectiveness, yet explaining why it had not attained full measure of succes.

It should be immediately pointed out, however, that the second question involves detailed information of the constitution, organization and personnel of both the Council and the Federation—upon inquiry it may be established that the two bodies are fundamentally different and the premise stated in the query therefore entirely unjustified. Such an investigation is not the present object; it is rather to inquire into the reason why Engineering Council did not attain its expected amount of influence. This known, some of the reefs and shoals along the course of the new organization will be charted, and a voyage steered accordingly.

Engineering Council, it will be recollected, is the child of the United Engineering Societies, which, in turn was formed by the four so-called Founder Societies—Civil, Mining, Mechanical and Electrical Engineers—and, quoting their official literature is an "organization of National Technical Societies of America, created to provide for consideration of matters of common concern to Engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible." The American Society for Testing Materials and the American Railway Engineering Association are also member societies. The executives of each of the member societies appoint representatives, who have subdivided their number into various committees, the personnel of which do whatever is done along their delegated line of activity. Their funds have been meager, being limited to some $13,000 annually contributed by the member societies.

Well informed engineers have characterized Engineering Council as an imposing body which did nothing. This is doubtless too harsh a criticism, for the Council has done a great deal of good work—much of it in a pioneering way, by trial and error. Yet unquestionably there has not been the activity in any line that was expected nor hoped. By its mode of organization about all it could do was to start the ball rolling along a desired path, and it had no means of reaching out into the great body of engineers in this country to get them behind the ball and keep it rolling faster. Consequently and naturally it settled back into rest.

In other words, the insurmountable defect in Engineering Council was its lack of connection with the "rank and file." All its admitted shortcomings can be ascribed to that one fact. The individual engineer knew very little about Engineering Council—he had no part in its actual organization beyond his collective urge that engineers organize nationally for economic ends. If he knew anything at all about Engineering Council, he probably felt that it should actively prosecute welfare work without any further help from him; was it not the body of men selected to do that particular job? Being thus built from the top down, it had an imposing head, but lacked a numerous body of men intelligently interested in its aims. Lacking this, it lacked the necessary funds even to operate effectively, let alone to sustain and widen the interest. Consequently only the close insiders actually knew what those at the head were doing, or what difficulties they were encountering.

A moral can easily be drawn from this little bit of history. The new Federated American Engineering Societies must have the interest of its ultimate members—the individual engineer. Only if it has this in good measure can any great success be attained.

---

*Editorial in July 7 Chemical & Metallurgical Engineering.

Operation Methods and Cost Data on Concrete Road Construction

By LOUIS A. [illegible]

The Holm Page Co. of Rockford, Ill., began operations about the middle of 1919 on Project No. [illegible], a stretch of the Peoria road extending 3 miles north and 4 miles south of Henry, Ill. In November, 1919, when they were forced to suspend operations for the year [illegible] completed approximately 1¼ miles of finished pavement. It so happens on this job that the only available gravel and sand is located in the town of Henry. This necessitated a lengthy haul of 4 miles, part of which haul was through a low, swampy section. A 10-ton "Caterpillar" tractor with Troy trailers was employed to deliver the material to the job.

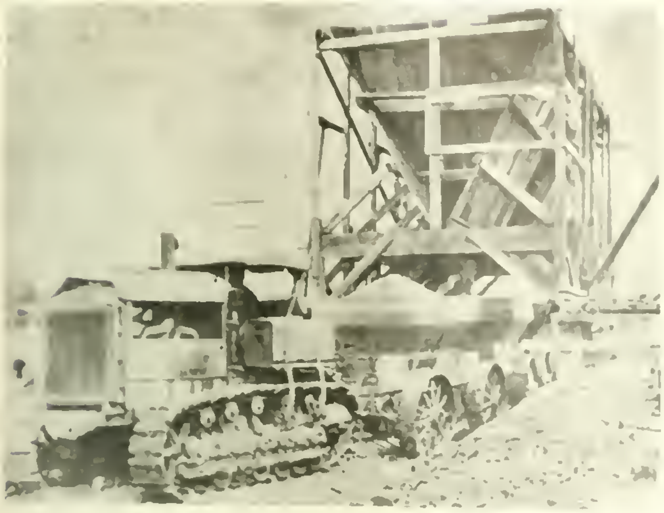


Fig 1—Tractor-Trailer Train at Storage Bin.

In 1920 a 5-ton "Caterpillar" tractor was added to the outfit which practically eliminated teams on this job. The cuts and fills were very light and the surface was very hard. Being an old gravel road, scarifying and grading was done with an Austin Rip Snorter and a "Caterpillar" tractor. With this combination it was possible to scarify approximatly 1 mile per day for a 16-ft. road and to keep the grading completed well in advance of the mixer. This work being done under the Illinois Highway Commission's specifications, which allowed only ¼ in. variation in the sub-grade and being held strictly to this allowance it was found after some experimenting that to insure uninterrupted operation of the mixer, correct thickness throughout of the pavement and a firm sub-grade that the most economical method was to hand finish the sub-grade, considering the hard gravel surface that had to be finished within ¼ in.

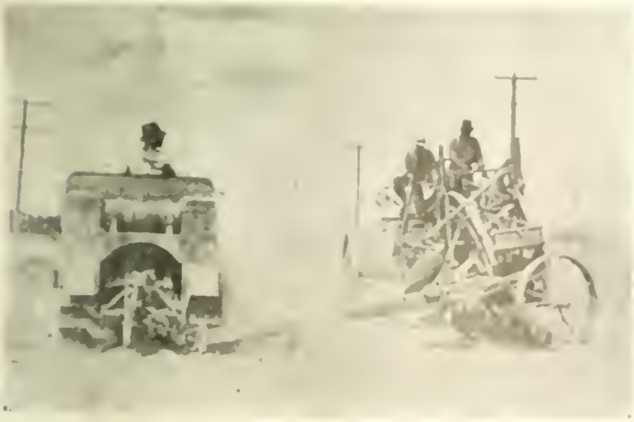


Fig. 2—5-Ton "Caterpillar" Turning with Austin Grader.

The sand and gravel were obtained from Chillicothe, Ill., which, being on the same railroad and but 15 miles away, ameliorated considerably the difficulty in obtaining coarse aggregate. The sand and gravel was unloaded with a Byer's auto crane with ¾ yd. bucket into an overhead bin. The "Caterpillar" and trailer train were then loaded by gravity from the bin. It was interesting to note the [illegible] and hauling cost of the material delivered from the bin to the sub-grade and the method of placing the material for the mixer. To obtain the greatest net load with the least tare weight 8 in. side boards were put around each Troy trailer. In this manner 5 Troy trailers with side boards would haul as much as 6 regular trailers, or a net load of 30 tons.

The following table shows the different lengths of haul, tons delivered per 10 hours, the trip time and the cost per ton mile for the various lengths of haul:

Haul, length miles	1	[illegible]	[illegible]
Tons delivered 10 hrs.	[illegible]	[illegible]	[illegible]
Cost per ton mile	[illegible]	[illegible]	[illegible]
Trip time	[illegible] Min.	[illegible] Min.	[illegible]

There seems to be some question still in the minds of contractors as to which is the best method of placing material on the sub-grade, in the ditch or on the shoulders. All

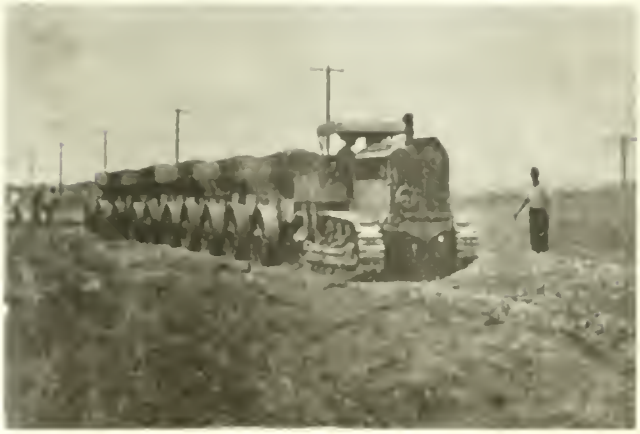


Fig 3—Tractor-Trailer Train Hauling 30 Tons of Gravel.

methods were employed at the beginning of this job, but at the present time the gravel is dumped on the one side of the sub-grade and the sand and cement placed on the opposite shoulder.

This method allows room on the sub-grade for the wheelers to work, avoids congestion and eliminates a great deal of work, which would result if the material had been placed in the ditches, or if the gravel had been placed on the shoulder. It will be noted in Fig. 5, that waste is practically eliminated; the gravel and sand shovelers being able to keep the sub-grade and shoulders clean. It should be noted also how the wide tires of the trailers have smoothed and rolled the sub-grade.

The construction methods, being simple and flexible, are facilitated by a complete understanding and co-operation between the contractor and the resident engineer. The work was not handicapped by the necessity of maintaining the road for traffic. This added materially to the uninterrupted progress of the work. Another factor which added materially to the success of this project is the organization which has been perfected by Mr. Frank Miner and Mr. Kirkendall. It is a result of serious thought and contrivance to overcome the ever present labor question and delivery of material. Every man has a task to do and when he has finished he has a breathing spell. The whole scheme works to the end of having each man see that every other man does his share

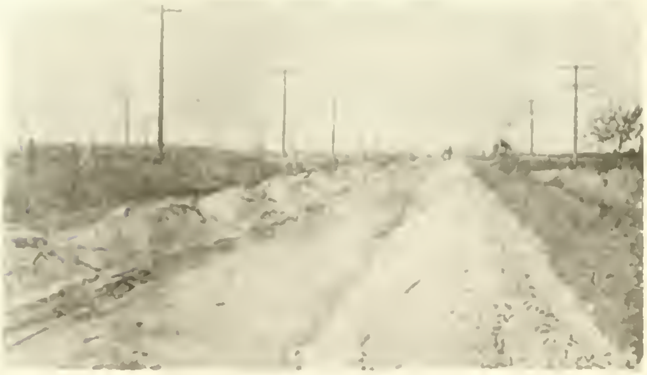


Fig. 4—Gravel on Subgrade; Sand on Opposite Shoulder.

of the work, with the result that the concrete mixer is going full blast 10 hours a day.

In the early part of 1920 a small industrial track about 200 ft. long was laid along the shoulder. Small cars with 2-batch boxes propelled by man power were used to bring the aggregate from sub-grade to the mixer where it was dumped in the pan with a small self-propelling crane. With such an outfit it required 41 men on the concrete crew and the highest daily record was 250 ft. of finished roadway. Recently this system was changed, the industrial railway discarded and the aggregate wheeled to the pan. This required placing the gravel on the sub-grade and the sand on the opposite shoulder. This system requires 30 men distributed as follows:

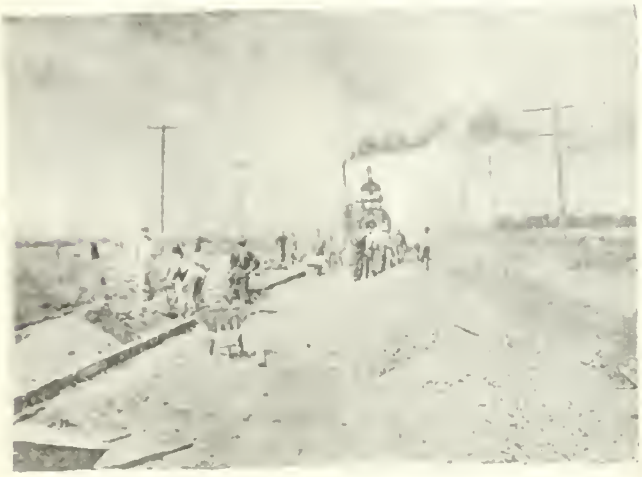


Fig. 5—Wheelers and Mixing Plant.

2 Men on the tamping machine.
2 Men at the spout.
1 Engineer.
1 Fireman.
2 Men carrying cement from the stock pile.
1 Man dumping cement into the pan.
4 Men wheeling gravel.
8 Men shoveling (2 for each gravel wheeler).
2 Men wheeling sand.
2 Men shoveling (1 for each sand wheeler).
3 Men bringing up forms and placing them in advance of the mixer.
2 Men covering up the green concrete with earth and sprinkling.

As stated before, each man has a very definite task to perform and with such an arrangement the daily average is 415 lin. ft. per day or 738 sq. yd. of finished concrete. The aggregate is mixed in a 4-bag batch Foote mixer. It is mixed for 1 minute, the time being regulated by a batch meter on the mixer. The mix on this project is $1:2:3\frac{1}{2}$. Two men set the necessary 660 lin. ft. of forms per day.

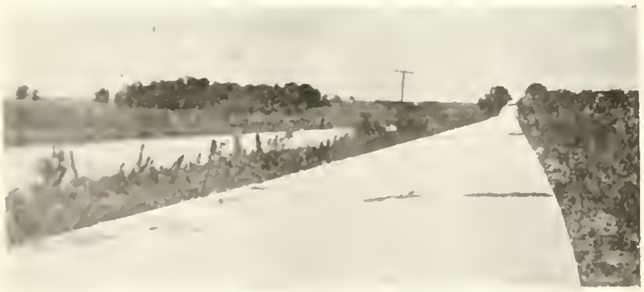


Fig. 6—A Finished Section of the Road.

The Lakewood finisher requires but two men for the complete operation and easily finishes the daily output of this organization.

The concrete is 16 ft. wide, 7 in. thick at the sides and 8 in. thick at the center. No expansion nor reinforcing whatever are used. At construction joints a $\frac{1}{2}$ in. opening is left and later filled with tar to insure a smooth, sound cohesion between the old and new work.

The labor situation in this vicinity, while it is not serious, is a very vital factor. At the present time labor at 50 ct. per hour with board at $1.00 per day is just sufficient to keep the job moving.

The cost data contained herewith includes labor, fuel, oil, interest on investment, depreciation on equipment, repairs, maintenance, etc.

The personnel handling the work on this job are: Frank Miner, General Manager for Holm Page Co.; Gene Kirkendall, Superintendent; E. B. Blough, Resident Engineer for Illinois Highway Commission.

Relation of Highway Transportation to Increased Production*

By GEORGE M. GRAHAM,

General Sales Manager, Pierce-Arrow Motor Car Co.

If anyone doubts how far transportation affects prices, let him recall that the great obstacle to a necessary increase of railway freight rates is the fear that such a raise will add to virtually all living costs.

Freight now moves over the United States via the following:

15,000 miles of canals and inland water ways,
359,000 miles of railways,
2,753,334 miles of highways.

In discharging its distribution function, the highway presents potentials not generally understood. The total of surfaced roads in the United States is greater than the railroad mileage, being 296,290, 12 per cent of the total, against 250,000 miles of railroad. It should be freely conceded, however, that much of what is here termed surfaced road is barely passable.

Exact tonnage figures are not available. The best estimates show that on the Great Lakes and Mississippi in 1918, 90,000,000 tons of freight were carried. In the same year 2,504,000,000 tons were moved by rail, and 1,200,000,000 by motor truck.

Highways have fallen short of carrying their share because only within the decade has a medium been developed to escape the limitations of the man-drawn, ox-drawn and horse-drawn vehicle, used for 50 centuries.

Many elements have combined to prevent the rapid application of the motor truck to highway transportation. It was not like Adam, born mature. It had first to be perfected that its efficiency might declare itself.

We have been hampered by ill-considered and in many ways unjust legislation. Bad roads have retarded our development and in this connection I ask you to note that our trucks have been just as much sinned against by bad roads as they have sinned by damaging such roads.

But the greatest immediate obstacle to the expanding use of trucks has been our failure to fit in our activities with those of the railroads.

In spite of all these handicaps this development has already carried far. I should like to illustrate the progress with an example from officials records.

Importance Recognized by War Industries Board. During the world war the most drastic powers ever vouchsafed any governmental agency were vested in the War Industries Board. These powers included arbitrary control of fuel, transportation, raw material and labor. The manufacturer could operate only providing the War Industries Board had classed his output a war essential.

The motor truck industry in due course was summoned to Washington to prove its case. It was told that, with steel lacking for war purposes in France, the misuse of one pound was treason, and that only under conditions of utmost urgency could steel be granted for trucks to be used in this country.

The reply made by the motor truck industry best proves the place taken by the power vehicle in our transportation fabric. Its spokesman submitted to the War Industries Board a list of the industries the Board itself had voted to be essential to the war program. There were 71 kinds represented. All carried full priorities.

An analysis showed that of the 71 kinds of manufacture, 66 were using motor trucks to speed up production. These included thousands of the biggest firms in the United States. The Board immediately granted the steel.

I believe that an almost equally forcible case could have been made for the passenger car, for that too must be considered in all questions involving highways transportation. The utility use of the motor car has won for it a place as a staple commodity. It is essentially a transportation medium.

---

*Abstract of an address delivered at the 8th annual meeting of the Chamber of Commerce of the United States, held at Atlantic City, April 27 to 29.

Railroad Men Advocate Trucks for Short Hauls.—Mr. C. A. Morse, also of the Railroad [illegible], has offered this opinion:

"Considered as a unit practically [illegible] road branch railway lines feeding trunk lines [illegible]. The traffic gathered by them is turned [illegible] with a deficit attached, which has to [illegible] the main line movement before any p[illegible]. It would be a decided advantage if this traffic [illegible] delivered to the trunk line by means of motor [illegible]."

R. C. Wright, General Traffic [illegible] of the Pennsylvania R. R., has stated that [illegible] handling L. C. L. freight up to [illegible] resulted in the appointment of a committee [illegible] the American Railway Association to analyze [illegible] and to welcome overtures from reputable [illegible] truck companies to handle such freight.

We do not like to dwell unduly [illegible] established the place of the truck [illegible] the President of the United States it [illegible] virtually every war official of prominence [illegible] practical aid given by motor trucks [illegible] can be led to peace needs.

Railroads have learned that prosperity [illegible] alone in terms of tonnage.

Formerly the railroad in its capacity [illegible] was not in a position to refuse unpr[illegible]. Now this can be diverted to a new and [illegible] which permits the railroad to concentrate [illegible] freight.

Temporarily our railroads have reached the [illegible] capacity. As now equipped they can handle no greater volume. Railway Age says they are 712,100 freight cars short. Only 50 per cent of locomotives needed are available. Five years is suggested as the minimum time in which railroad facilities can be brought to normal.

Meantime is it not sound logic that present railroad equipment should be limited to remunerative work, leaving the short haul L. C. L. to other mediums?

No rational person considers the motor truck a rival of the railroads in long haul traffic.

Trucks Cannot Compete with Railroads Over Long Distances. The truck has performed wonders in occasional emergency service, but the labor factor eliminates it for long distance work.

A modern freight train will move 3,000 tons with a crew of six men. The same tonnage by motor truck would require 600 5-ton trucks, at least 600 drivers and possibly 600 helpers.

That there may be wisdom in a re-arrangement of our present methods is suggested by a brief analysis of the facilities of the short haul steam railways of the United States. This class I have limited to railroads having a maximum trackage of 100 miles, although many lines with more than this render a short haul service.

Short Haul Lines and Their Equipment. The figures here obtained from the Short Line Association, and are accurate as of April 1. They show 659 roads of 100 miles or less. Their total mileage is 16,860, an average of 25.6 miles each. 160 are less than 10 miles in length, their average being 6.4 miles. 419 roads are less than 25 miles long, their average being 12.6 miles. The total number of locomotives of the 659 roads, is 2,491, an average of 4 each. 137 roads have but one locomotive.

A foremost railroad authority has frankly conceded that no longer will such lines be constructed either as individual lines or branches of trunk lines.

If Mr. Wright is correct in his figure of [illegible] miles as the minimum distance for L.C.L. haulage, then there is no place for almost two-thirds of them. The future tendency will be to substitute other agencies.

In planning to eliminate such roads there arises the problem of taking care of their owners. Stockholders should be protected, but a system which is economically in error cannot be maintained artificially.

In many cases these lines were established by trunk railroads to serve as feeders. Their stockholders might be compensated through an exchange of their securities for stock in the parent company. It is possible also to sell at profitable prices all equipment, including rails, freight cars and locomotives. [illegible] taken over by trucking companies.

Typical Case of Truck Line vs. Railroad. [illegible] the suggestion that [illegible] themselves embark in motor truck haulage. It [illegible] with the growing rivalry between short line rail [illegible] and motor truck haulage companies I have selected from a mass of litigation one case [illegible]. It [illegible] arguments good and bad [illegible] the handicaps and possibilities of both sides.

This case was heard before the Public Service Commission of Nevada. It concerns the efforts of two [illegible], Ginocchio Brothers, to get a certificate of public convenience to operate a motor truck haulage company. Opposed to them was the Virginia & Truckee R. R. Co., operating between Reno and Minden.

The railway company had much of the [illegible]. It was in possession of right of way and claimed to be operating satisfactorily. It paid its taxes. It asked that Ginocchio Brothers be compelled to deposit bonds to the amount of $10,000, establish freight stations and passenger depots and adhere to complete tariff schedules. It argued that the truck company could not operate during part of the winter, whereas the railroad was an all year service.

But especially instructive was the railroad's presentation of the financial phases of the subject. It was set forth that the net income was only $8,817 for the year ending June 30, 1919, that the scrap value of the railroad was $450,000, that if the owners saw fit to junk their assets and invest in staple securities, they could get an income of $27,000, or three times as much as their operating gains.

It was also urged that the addition of another carrier would depreciate the revenue of the railway, result in poorer service and higher charges.

Ginocchio Brothers argued service. They proved that their trucks covered 51 miles between Reno and Gardnerville in 3 hours and 20 minutes, picking up and delivering freight at residences, farm houses, warehouses, and stores. Two or three days elapsed in similar railroad freight shipment.

The truck service was said to be no more disqualified by storms than that of the railway.

Many customers supported the Messrs. Ginocchio, and said they gave a service not possible by the railroad.

The Commission ruled that railroad freight service for short distances in less than carload lots has become wasteful and obsolete. It granted the right of operation to Ginocchio Brothers, welcomed the addition of such service for the agricultural, live stock and mining sections of the state and recommended that the railroads install similar facilities.

Properly speaking, there never should have been any conflict in this case. Under a proper system of co-operation, the effort would be to find out which of the two mediums could most economically, efficiently and profitably serve this section. This determined, the right facilities could be applied, and the other withdrawn.

Trunk Lines and Railroads Should Co-operate.—With co-operation and constantly increasing efficiency motor trucks should be able to serve the great central trunk railway lines by hauling to them, free of deficit, a volume of tonnage to be moved distances in bulk.

State utilities commissions everywhere are studying highway motor transportation. Such researches divulge amazing instances of service. There is one [illegible]-mile route between Akron and Cleveland which relieves the railroad between these cities of a demand for [illegible] freight cars weekly, suggesting a possible yearly saving of [illegible] cars for other purposes.

The great strain in our modern transportation system is to be found at the terminals. Freight cars move on an average of only 25 miles per day. We also have the spectacle of something like 2,400,000 freight cars with an average capacity of [illegible] tons carrying seldom as an average more than 32 tons in carload lot shipments and 7 tons in L. C. L. shipments. If we could by abolishing junction and terminal delays bring the daily average mileage up to 37½ miles per car there would be the equivalent of an addition of 1,200,000 cars.

At such centers as New York, Cincinnati, Minneapolis, Cleveland, Louisville, Grand Rapids and St. Louis motor freight terminals are exercising important influences on transportation and production.

In New York trucks collect freight from various points within a radius of 30 miles, then haul it to an outlying terminal, Mott Haven, to escape central congestion. It is then shipped in railway freight cars to Boston and thence distributed by trucks within a radius of 30 or 40 miles.

This properly allots haulage—the short distance for the truck and the long distance for the railway. It eliminates two or three minor railroads and consequent congestion and delay at the junction points.

What Trucks Are Doing for Cincinnati Terminals. The entire transportation industry of the United States is studying with interest the achievement of Cincinnati, recently informatively presented in the Saturday Evening Post by Mr. Hungerford.

In Cincinnati railway terminals are bunched, yet owing to trackage congestion, an average of 2 days and 14 hours used to be required to move a freight car a few miles between station. Now similar distances are covered in 14 minutes by fifteen 5-ton trucks, which transfer freight from terminal to terminal. The trucks also tap the suburbs, bringing in freight in ample time for daily distance shipment in bulk, and saving anywhere from one to four days.

Every freight house has standard truck bodies which attach to the chassis. When the railroad car comes in, the freight is quickly snatched from it and allotted to bodies destined for the various stations. Only 5 minutes is consumed in taking off one filled body and putting on another.

The service releases, in a year, 66,000 box cars from trap work for profitable distance haulage. The cost is 80c per ton as against from $1.20 to $1.60 by previous methods.

Solve the terminal question, and you solve extravagant costs as well as time lost.

One expert, B. F. Fitch, president of the Motor Terminals Co., of New York and Cleveland, has said that the installation in the metropolis of a motor system similar to that of Cincinnati would save New York consumers $15,000,000 in freight costs yearly.

Many items of cost inseparable from railway freight can be eliminated when short haul shipment is made by truck. Included in these are items of boxing, crating, demurrage charges, teaming between terminal points, increased weight caused by boxing, and much incidental labor and clerical work in connection with billing, checking, tracing, etc.

All these economies exert their influence on production costs and volume.

Length of Haul and Truck Costs.– W. J. L. Banham, general traffic manager of the Otis Elevator Co., presents a very interesting table, in which he shows how truck costs increase in proportion to the increased length of the haul.

	Road miles.	Freight cost per 100 lbs.	Motor truck cost per 100 lbs.
New York	12	$0.88	$0.15
Passaic, N. J.	6	.88	.15
Paterson, N. J.	10	.88	.18
Trenton, N. J.	51	.88	.55
Philadelphia, Pa.	88	.98	.75
Bridgeport, Conn.	70	1.12	.75
New Haven, Conn.	87	1.12	.85
Providence, R. I.	214	1.21	1.15
Port Jefferson, L. I., N. Y.	71	.98	.75
Asbury Park, N. J.	46	.94	.45

Ten Thousand Motor Haulage Lines.– Ten thousand motor truck haulage lines are now registered with the National Automobile Chamber of Commerce by corporations or firms. This organization estimates that there are another 10,000 lines being operated by individuals, who own and drive the trucks. Several of the corporations have made investments ranging from $1,000,000 to more than $2,000,000.

We believe that to prove our ability to facilitate delivery is to establish our helpful relationship to production. We should, therefore, like specifically to point out some phases of our service in the four main types of production.

Food may well be dealt with first.

Importance of Trucks in Handling Food. In the United States 26,000,000 food producers are trying to feed themselves, 79,000,000 additional American citizens, and many Europeans. It is an enormous task. It has been made harder by waste from inadequate distribution. No less an authority than Herbert Hoover has said that 30 per cent of the perishable farm produce in the United States rots on the ground, because of the farmer's inability to get it to market. Over American highways passes a volume and value of food products of astounding dimensions.

Agricultural crops, dairy products, poultry, produce and domestic animal production reached in 1918 an aggregate of more than $21,000,000,000. There were 5,638,000,000 bu. of cereal; 11,818,000 bales of cotton; 309,109,000 bu. of potatoes; 197,360,000 bu. of apples; 6,549,000 tons of sugar beets; 10,500,000,000 lb. of pork; 589,000,000 heads of poultry; 1,921,000,000 dozens of eggs; and 8,429,000,000 gal. of milk.

United States Senator Arthur Capper, of Kansas, points out that the motor truck is essential to the development of the agricultural interests of America, and shows $70,000,000,000 to be invested in farms—a sum equal to the total of any three other industries that might be named.

Stimulating Food Production.—Adequate transportation helps food production by exerting these four principal influences:

1st. Gives wider producing area.

2nd. Definitely lowers cost of foodstuff without detriment to farmer by saving much excess transportation cost. This is important, because under present methods the farmer gets but 35c for products which cost the consumer $1. This means that two-thirds of the $1 is expended in distribution.

3rd. Shortens time of transit to market, thereby increasing the farmer's producing hours on the farm.

4th. Assures the prompt arrival of perishable items at the door of the consumer when they are in best condition and command the highest prices.

Trucks are being applied to food distribution in varied ways. The farmer hauls for himself and his neighbors. Local transfer companies are entering the field, but the biggest development is in the organization of what have come to be known as rural motor express line. The Highways Transport Committee made itself responsible for this movement, when, during the war, it was straining every effort to increase the food supply.

There are now known to be 3,000 regularly established rural motor express lines in operation, and some of them involve a considerable investment. The number is constantly increasing. Their economies have not yet been reflected in any general decrease in food prices, mainly for the reason that the application has not become sufficiently general.

There are, in the United States, 6,361,502 farms. All over 80 acres could find profitable use for one or more trucks. Assuming the 80-acre farms to be but one-third of the total, this would mean the use of 2,120,500 trucks, whereas actually not more than 78,000 are now assisting the farmer to market more food, in better condition and at lower costs.

Unwise Truck Legislation Harmful to Public Interest.—Many legislators have voted for legislation inimical to the motor truck from a feeling that they thus served the interests of the farmer. No error could be greater. The motor truck offers a haulage economy. It performs its function more cheaply than the horse-drawn vehicle. In reality the haulage of farm produce by motor truck is cheaper than haulage by team.

This statement has the support of the Department of Agriculture. The 1918 figures of the Bureau of Crop Estimates show the cost of hauling in wagons per ton mile as compared with motor truck haulage to be as follows:

	Wagon.	Truck.
Wheat	$0.30	$0.15
Corn	.33	.15
Cotton	.48	.18

Motor truck hauls from farm to shipping point averaged 11.5 miles, while wagon hauls averaged 9 miles. Motor trucks made 3.4 round trips per day, while wagons made 1.2 round trips.

So valuable have been the results obtained from the movement of food over the highways by motor truck that the state of Maryland has delegated authority to its Director of Farm Products to maintain and operate motor lines along the state highways to and from markets, and to maintain a service to and from terminals, docks, and depots for the collection and distribution of farm products. New York State is investigating this subject. The Nebraska State Railway Commission has recognized truck haulage and established a price rating on 100 kinds of articles.

Some extraordinary economies have been achieved. Milwaukee gets its milk by trucks, over concrete roads, at a freight savings of 2 ct. per quart, which means a saving of $1,000,000 yearly to the people of that city.

Trucks haul the Maryland p[illegible] packing plant where the product is loaded [illegible] refrigerator cars. They thus act as a profitable fe[illegible] for which the packing plant is locat[illegible]

The movement is also spreadin[illegible] shipment.

In 1919 there were received in [illegible] by motor truck, from nearby points more hogs than [illegible]. For the year more than 711,000 hogs, 48,[illegible] calves and 59,000 sheep arrived by gasoline tr[illegible] physical condition and at a material savin[illegible] freight cost.

Not only is food production st[illegible] way transportation from the farms, but mention [illegible] made of the help rendered by mot[illegible] plants which mill, preserve, produce, refine, r[illegible] and store various food products. These are vi[illegible] general scheme of production and di[illegible]

How All Interests Can Assist.—If [illegible] that the highways may facilitate distribution and [illegible] I should like to suggest to the gentlemen [illegible] three main ways by which they may assist.

1st. We ask that you assist in allotting [illegible] and motor trucks their proper kind of haulage [illegible] may discharge its true function in transportation.

2nd. Your help is solicited to protect the motor truck against excessive taxation and unfair, ill-advised and restrictive legislation. Forty-five legislatures will meet next year. They will consider at least 3,200 motor vehicle bills. Business men should help law makers to realize that the motor vehicle is an economic asset, so that there may be enacted only laws which are fair and beneficial to highway transportation and the general public.

3rd. From a practical standpoint it is above all things vital that you aid us to establish an efficient system of highways under Federal direction.

Right roads must be available 365 days of the year. This involves a system of snow removal. During the war there were organized snow removals under state and national direction. This work could well be continued now, especially keeping open that 20 per cent of roads on which 90 per cent of highway traffic is concentrated.

Limit Truck Weights on Highway.—The automobile industry recognizes the menace to the highways of excessively heavy trucks, and advocates that no vehicle weighing more than 28,000 lb., gross load, shall be permitted the use of the public roads as at present constructed. It believes also that the increasing use of pneumatic tires on trucks will reduce the damages.

But we are equally convinced that the highways of the future should be the servant of transportation, not its master. They should be prepared to accommodate a constantly increasing volume of haulage carried by whatever size of truck shall prove most swift, efficient and economical.

Public interest is shown by the expenditures for hard-surfaced highways. According to estimates of the Bureau of Public Roads of the United States Department of Agriculture, these, in 1919, set a new record with a total of $138,000,000. But this figure is small in comparison with the computed available total for 1920 of $623,000,000.

Need for National System of Highways.—We must co-ordinate all this road building into a comprehensive system of highways under national control. The United States Chamber of Commerce in a resolution passed at St. Louis is already committed to such a program. We believe that our hopes in this direction will be best served in the passage of the Townsend Bill now before the Senate of the United States.

This bill calls for a national system of highways to be built and maintained by the Federal Government under the supervision of a Federal Highway Commission.

The Townsend Bills calls for an eventual expenditure of $425,000,000 to be spread over five years. To those who argue that our financial condition forbids such a comprehensive construction, let us concede that economy is a right principle, but it should not be pressed to a point where it defeats investments necessary to prevent loss.

The high cost of living is no myth. Neither is the mud road. The prime reason for high costs is inability to deliver maximum production at prices permitting a profit to the farmer and a saving to the consumer.

Special Truck Body for Delivering of Aggregate

An economical method of delivering aggregate was employed by the People's Lumber Supply Co. [illegible] contract for constructing a state aid road for the State Roads Commission of Maryland. The method is described by Mr. John N. Mackall of the Commission in the April issue of Successful Methods, to which we are indebted for the matter that follows.

The project which was ideal for this [illegible] about [illegible] miles in length, with the railroad siding for the delivery of materials in the center of the job. There existed at this point a coal trestle a sufficient height above the ground to permit the contractor to erect bins under the trestle, so that the sand and stone could be unloaded by gravity in the bins, and these bins are still sufficiently high to permit them to be emptied by gravity into the trucks on which measuring boxes have been mounted.

One-ton Ford trucks with especially constructed two-compartment bodies were used to transport the material. These bodies, constructed of timber so that they could be dumped by one man, were made in two compartments, each one independent of the other, and each holding 12 cu. ft. of material, making a total load of 24 cu. ft. The boxes were so marked as to permit the placing in them of 8 cu. ft. of stone and 4 cu. ft. of sand.

Special 2-Compartment Truck Body

The trucks then were brought up to a point where the subgrade was shaped approximately 200 ft. in front of the mixer, at which point they were turned around and backed to the loading skip. One of these boxes was dumped, and while this batch was being mixed, the truck was shifted slightly so that the second batch could be dumped directly into the skip.

By this method, absolutely clean aggregate was delivered to the mixer, and the cost of unloading, hauling, proportioning, mixing and placing of the concrete was done at the following unit cost:

2 men finishing concrete, at $4.00	$ 8.00
2 men on template, at $4.00	8.00
2 men spreading concrete, at $3.50	7.00
1 man operating bucket, at $4.50	4.50
1 man operating mixer, at $5.00	5.00
1 foreman, at $4.00	4.00
1 man on cement, at $3.50	3.50
1 man cleaning up at hopper, at $[illegible]	2.50
[illegible] men unloading cars, at $[illegible]	[illegible]
[illegible] men loading trucks, at $[illegible]	7.00
1 foreman, at $6.00	6.00
5 Ford trucks, at $10.00	50.00
1 [illegible]-ton truck, at $25.00	25.00
	$132.00

The average day's run was 250 ft., or 416 sq. yd., which makes the unit cost 30 ct. per square yard, which is unusually low.

The construction of the dump boxes was unique and worth a complete description. They were made on a pivot located so that the box would remain in place when loaded. The bottom of the box projected about 2 ft. beyond the limit of the body. When the tail gate was open, the material would run out on this projection, and the extra weight would cause the body to tilt back, and the contents to drop into the skip.

This feature enabled the driver to raise and lower the bodies and open and close the doors without moving from his seat, thus eliminating much delay and expense.

Aggregate from Platte River Used in Concrete Road Construction in Nebraska*

By A. S. MIRICK

[illegible] Nebraska [illegible] Public Works.

The road building stone supply of Nebraska is confined to the southeastern portion of the state and consists of limestone deposits of varying hardness. Some samples show a French coefficient of wear of eight but the hard strata are so distributed in the quarries that it is almost impossible to get a uniform product that would be suitable for an aggregate for concrete pavement.

The Platte River runs through the central part of the state, and for ages it has been rolling down the feldspar and quartz rocks from the Rockies and depositing them in Nebraska. In many places this material is pumped up, screened and graded, and makes splendid aggregate for concrete. The material in question however, violates a favorite condition that engineers have made a part of their fine aggregate specifications: that the particles must be sharp. This theory has been proven fallacious, for the rounded particles, if they are clean and hard, have been found to develop more strength than the sharp variety.

The material pumped up from the Platte River has another characteristic that has caused engineers to be cautious, that is its fineness. One who is familiar with Prof. Abrams' tests, knows that he has developed a theory that if a material shows a certain modulus of fineness, depending upon its grading, this material may be composed of any sized aggregate. Even the grading is relatively unimportant in comparison with water content.

Tests of Platte River Aggregate.—With this theory in mind, it was decided to send a sample of the Platte River material to the testing laboratory of the Bureau of Roads, Department of Agriculture, Washington, determine whether so-called Platte River gravel would meet with their approval for use on concrete paving work in Nebraska. This matter was an important one as it meant utilizing the greatest supply the state has for paved roads. The analysis of the sand-gravel mixture was as follows:

Passing ¾-in. mesh screen and retained ½-in. screen	2.0
Passing ½-in. screen and retained ¼-in. screen	12.7
Passing ¼-in. screen and retained ⅛-in. screen	85.5
Retained on ¼-in. screen . . . Per cent.	14.7
Passing ¼ inch mesh retained on 10 mesh	44.4
Passing 10 mesh retained on 20 mesh	27.9
Passing 20 mesh retained on 30 mesh	5.5
Passing 30 mesh retained on 40 mesh	3.1
Passing 40 mesh retained on 50 mesh	1.3
Passing 50 mesh retained on 80 mesh	1.9
Passing 80 mesh retained on 100 mesh	0.2
Passing 100 mesh retained on 200 mesh	0.5
Passing 200 mesh	0.5
	100.0
Loss by washing silt and clay	0.4

The sample consisted essentially of rounded fragments of granite, quartz quarzite, with a large amount of subangular quartz sand.

Samples of the material were tesed for compression and compared with Potomac River screened gravel. The mixture of the Platte River sand-gravel was 1 part of cement by volume to [illegible] parts of the sand-gravel. The Potomac River material was used in proportion 1 part of cement, 1½ part of Potomac River sand, and 3 parts of Potomac River gravel measured by volume. The dividing line between sand and gravel of course was the ¼-in. mesh screen; all that was retained on the screen was considered gravel, and all passing through considered sand.

Some 6 in. by 12 in. cylinders were prepared of concrete made from both materials and aged 7 days. Two test samples were prepared of each. The total loads sustained by the cylinders of Platte River gravel were 58,350 lb. and 65,940 lb. with an average of 62,145 lb. The total loads sustained by the cylinders of the Potomac River gravel were 57,780 lb. and 58,180 lb. with an average of 57,980 lb.

The average unit crushing strength of the Platte River sand-gravel concrete was 2,198 lb. per square inch. The average unit crushing strength of the Potomac River gravel concrete was 2,050 lb. per square inch.

As a result of this test it was decided to use this material for paving with concrete a portion of the Lincoln highway 5.94 miles in length running from Fremont to Ames.

The plans for this stretch of concrete paving called for a pavement 18 ft. wide, 8 in. thick in the center and 6 in. in thickness on the side. The pavement was laid in blocks 36 ft. long with a ½ in. elastic expansion joint separating each block from its neighbor.

Production of Sand and Gravel and Hauling.—The Platte River runs parallel to this road and material for the aggregate could be obtained with very easy hauls direct from the plants operating along the river in the immediate vicinity of the road. Consequently the contract was let for the construction of the road at a cost of $199,440.

The gravel is dredged from the shores of the Platte River. The effluent from the pump carries the sand and gravel to a series of sorting screens and chutes, where the fine and waste materials are returned to the lake pit. The material to be used is delivered into the bins ready for truck loading. The material is then hauled to piles located at convenient places along the road for storage. The hauling from the bins to the stock pile is done by trucks.

Near these stock piles a platform for storing cement bags has been erected, and all of the charges for the mixer are carried from the stock piles by means of Ford trucks. These Ford trucks are equipped with Lee dump bodies holding 21 cu. ft. of sand-gravel mixture. The sand-gravel mixture is loaded on the trucks by means of an automatic loader. This charge is rushed to the mixer, dumped, and the truck returns at a 50 miles an hour gait for another load.

Advantages of Hauling with Trucks and Special Dump Bodies.—The advantages of this manner of handling material from the stock piles to the mixer over the old method of hauling by teams are as follows:

The sub-grade is kept in good condition ahead of the concrete by the action of the over-sized tires of the Fords.

The speed of operation of the trucks obviates the confusion and congestion that occur with teams, since many teams must be on the road to handle the same amount of material.

It eliminates the old-time skinner, who sleepily dozed over a pair of mules, and utilizes the young man who has a real interest in motor vehicles, encouraging him to work at something he really likes and helping to solve the labor question.

Above all, it greatly diminishes the number of men required, and entirely eliminates the difficulties of using teams.

The Concreting Operations.—The concrete is mixed in a ¾ yd. Foote mixer. This mixer is equipped with caterpillar tractors that distribute the load of the mixer on the subgrade at a pressure of about 4½ lb. per square inch. The forms used are Blaw-Knox pressed steel forms that combine the qualities of a form with a track to receive the Lakewood finishing machine which was used.

As soon as the concrete has set, if the temperature is high, the pavement is covered by a tarpaulin. This is removed after a short period and a covering of not less than two inches of earth is applied and kept moist for a period of at least ten days.

Sieve analyses are made of the sand-gravel aggregate from time to time. Very close watch is kept on the material to see that it conforms exactly with the specifications. Very little variation of the coarser material is allowed and any deficiency in this respect has to be adjusted.

The work is supervised by the Department of Public Works of the state of Nebraska aided by the government.

This work, though it represents a small part of Nebraska's road building program, is being watched by engineers in the Middle West with a great deal of interest, for on the result of it may rest the solution of the problem of cheaper pavements for some of the central-western states that have no suitable material for coarse and fine aggregate. The successful use of the Platte River deposit will have a great influence in extending hard surface road systems in Nebraska and adjoining regions.

Preferential Order for Car Service for Road Material.—The Public Service Commission of Pennsylvania on July 10 issued a preferential order for car service to overcome the danger of interruption of the State highway building program. This is the first time such action has been taken in behalf of the state. The railroads are required to furnish 81 box cars a day for hauling cement for the state. It is stated at the capitol that as this order relates only to box cars it will have no effect upon the allotment of cars for coal distribution where the principal shortage in car supply exists.

---

*[illegible]

Machinery Reduces Labor Force and Increases Output in Alley Paving

New machinery is very rapid [illegible] in the roadbuilding and paving field [illegible] to find contractors getting along with [illegible] to one-half less the men formerly employed [illegible] while increasing their daily output.

The Schmidt Construction Co. [illegible] engaged in street and alley paving in that city [illegible] machinery for the speedy and economical loading [illegible] of material. Most of the work consists [illegible] paving. The work is scattered in different parts [illegible] it necessary to move the machinery [illegible] days. There is sufficient work ahead to keep this contractor busy until Dec. 1.

The average alley width is 15 ft. [illegible] in. A 1:2 [illegible] mix laid 7 in. thick, is specified. The average alley job consists of about 1,000 sq. yd. of concrete paving.

With his present equipment, consisting of 1 Jeffrey automatic loader, 1 Barber-Greene automatic loader, [illegible] Koehring mixer, and 3 gasoline propelled Clark Tructractors, the contractor is averaging 750 sq. yd. of alleyway per day. With hand labor the daily output was 600 sq. yd. or less, depending on weather conditions.

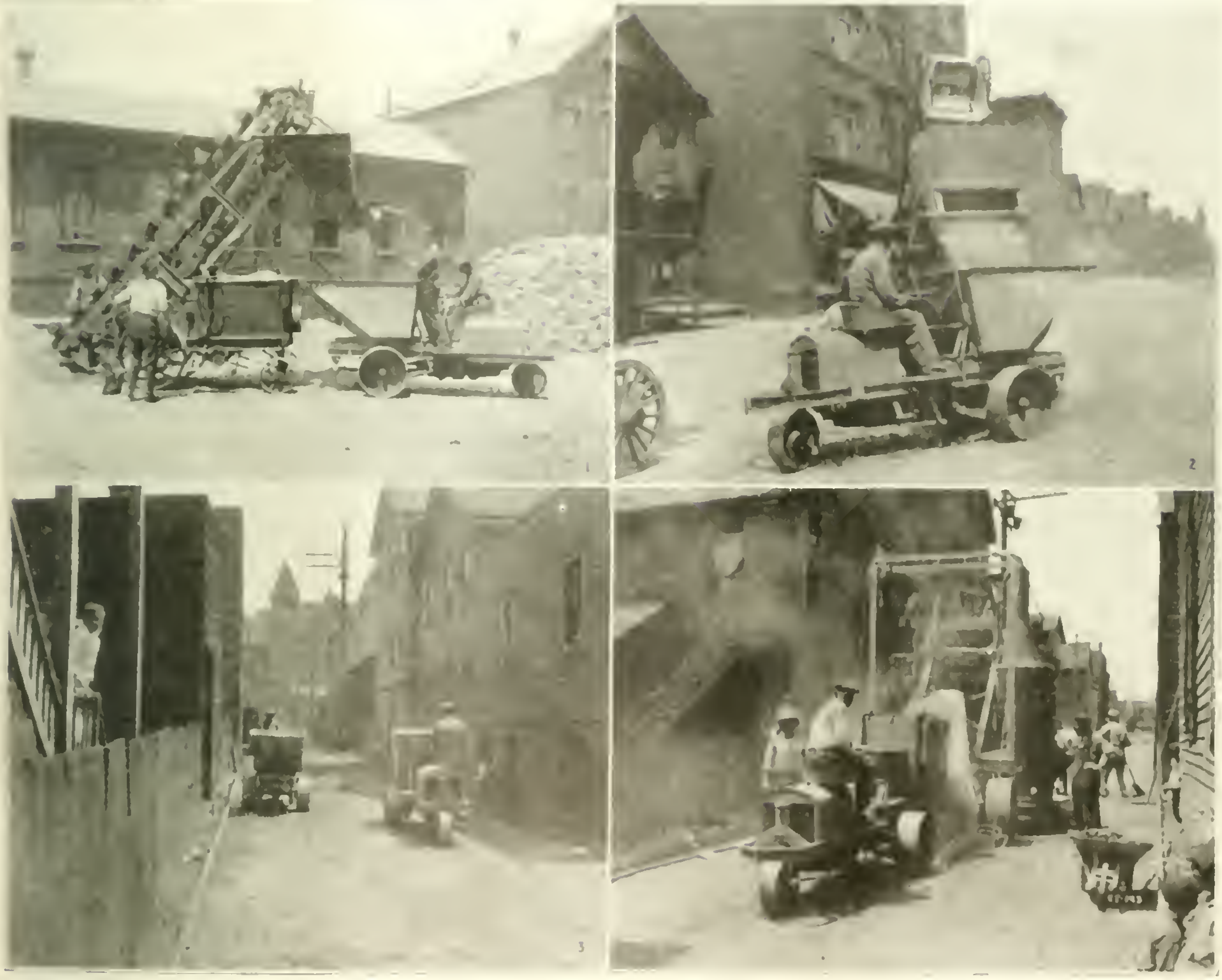
The Jeffrey loader is located at the sand storage piles and the Barber-Greene loader at the stone storage pile. Cement loading is done by laborers. On each trip the Clark Tructractor picks up 6 cu. ft. of sand, [illegible] cu. ft. of stone and [illegible] cu. ft. of cement. This batch of dry mixture is hauled by Tructractors and dumped directly into the skip of the paving mixer.

The [illegible] each Tructractor making [illegible] minutes. The mixer [illegible] of one batch per minute.

The following men are employed [illegible]:

Clark Tructractor [illegible]
Jeffrey Loader
[illegible]
Barber-Greene Loader
[illegible]
Koehring Mixer
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

Total men employed [illegible]



Labor Saving Equipment of Schmidt Construction Co. on Concrete Alley Paving at Chicago.

(1) Jeffrey Loader at Sand Pile Loading [illegible] Tructractor. (2) Barber-Greene Loader Loading Broken Stone. (3) The Connecting Link Between the Storage Piles and the Paving Mixer. (4) Tructractor Dumping Directly into Skip of Mixer.

The work is performed on a schedule and production goes on without a break. The mixer sets the pace for the work. The automatic loaders and Tructractors keep the mixer supplied. The heavy handling is handled by machinery. As a result there is practically no let up from beginning to the completion of the job and operations continue regardless of weather conditions. The average number of men employed has been cut from 32 to 20.

Georgia Motor Vehicle Tax Law Valid. The validity of the motor vehicle license tax act passed by the General Assembly of Georgia in 1919 was upheld by the State Supreme Court in a unanimous decision handed down July 6. The decision makes the automobile fund immediately available for highway construction purposes by permitting the governor to draw [illegible] warrants against it for this purpose.

Broken Stone Roads

By GEO. HOGARTH,
Chief Engineer, Department of Public Highways, Ontario

Highway development in Canada may be said to begin with the trail or bush road and, depending on the lightness or heaviness of traffic, to advance by well-defined steps to the state of earth road, then a gravel road, then a macadam road and finally, if finances permit and traffic is sufficiently heavy, the road becomes a bituminous or concrete pavement. For all time to come many miles of our highways will remain earth roads.

Some roads being more important and leading to railway stations or market centers, will have gravel applied to them as traffic increases, and the need for a better road arises and later when that traffic becomes heavy and approximates 200 to 500 vehicles per day, the need of a stronger road crust will be evident and a macadam surface of broken stone will be laid. Such a stone roadway will carry economically, with ordinary maintenance, a traffic up to 1,000 or 1,500 vehicles per day.

Broken Stone Roads for Light Traffic.—Broken stone roads for ordinary travel may be built at comparatively small expense where rock is situated close to the highway. The installation of a crushing outfit at any convenient point will provide in one season sufficient stone to surface a number of miles of roadway, and by crushing the stone so that all will pass a 1½-in ring, no rolling will be necessary. In operating such an outfit and building a road the usual procedure is to pass all stone over a screen after crushing and draw into one bin all the dust and chips up to ½ in. The rest of the stone passes into a second bin and is drawn away and spread on the road.

The road grade should first be properly drained and slightly rounded up in the center and a layer of the crushed stone from 10 to 15 ft. wide and 3 to 5 or 6 in. thick is placed. After the first layer of stone is in position and spread a coating of the screenings and dust is distributed on top of the first layer, and the road is left for traffic to consolidated. In this manner a broken stone road for light traffic may be constructed with the minimum of expenditure, and if limestone is used and care exercised in leveling and spreading the stone, a satisfactory result will be obtained.

Two-Course Macadam for Heavy Traffic.—Where it is desired to properly construct a one or two-course broken stone road for heavy traffic, more care is required in all the road-building operations. The preparation of the subgrade must be given close attention and the drainage of the roadway properly provided for. Side ditches with good outlets will be required and the bottom of the side ditch should be at least 2 ft. below the crown of the roadway. Many soils are found to be wet and soft and tile drainage under or alongside the stoned portion must be provided to draw away the water and permit the soil to dry out and harden. If the country is rolling, it will be found that tile drainage is absolutely necessary to dry out wet spots on hills, particularly at points from 50 to 200 ft. below the crest of hills, as it is at such points the ground water tends to come to the surface and by creating springs will cause the road to soften and break. By properly ditching and tiling the earth subgrade, it is possible to create at small expense a hard, dry surface upon which to place the foundation course of broken stone. Drainage is essential to roads and the money so spent is returned, because the well-drained road costs less to maintain and lasts longer than one that is poorly drained.

The earth subgrade, after being properly drained and graded is thoroughly rolled and the base course of stone is uniformly spread upon it. This base course may be 10 to 20 ft. in width and from 4 to 7 in. in depth, and composed of coarse, stony gravel, field boulders, broken stone or telford. The quality of hardness of the stone used in the foundation course is not important, as the wearing effect of wheels does not come on the base course, so that any stone is usually satisfactory. When the base course is in place a roller should be used to consolidate the stones and render them firm for the top course. The spaces between the stone in the base course may be filled by screenings or coarse gravel and the whole watered and rolled.

On top of the base course a depth of broken stone about 4 in. in depth is placed. This top layer is composed of stones about 2 in. in size, and as it is the wearing course of the road the quality, toughness and uniformity of the stone is important. Any good limestone may be used for the wearing course, but the hardness of the stones should be uniform as otherwise the quick wearing of the softer stones will create a rough road in a short time. The top course is thoroughly rolled and is then watered and screenings applied and spread over the stones to fill the voids. Brooms are used to sweep the screenings into all spaces and the surface is watered, broomed and rolled until hard and unyielding under the roller. A light coat of screenings is applied and the road left for a few days to dry out before being opened to traffic.

Maintenance and Repair of Macadam.—The broken stone road is readily constructed, easily maintained and readily repaired. It is a pleasant road to drive over and with proper maintenance is economical. It may be found that after being in use for years a broken stone road has small holes and ruts over its entire length. One method of preventing the road becoming rough is to establish a system of maintenance by patrolmen shortly after the road is built. Under ordinary circumstances one man with a 1-horse cart and a small outfit of tools will be able to patrol and keep in repair from 3 to 5 miles of road, and he will not need to be continuously employed to do that.

The repairs consist in filling the holes and ruts with large stone, covering the stone with screenings and tamping the patch tightly into place with a pounder. An experienced man will patch a road so that the road is smooth and the patches cannot be detected a few days after the work is done. After being under heavy traffic for some time a broken stone road may become rough and pitted, so that resurfacing is necessary. This work is undertaken by first scarifying and loosening the old surface, after which the stones may be leveled off and a new course applied, rolled in and finished the same as when building a new road. It is this ease of repair which makes the broken stone road one of the most economical to maintain and keep in good surface.

The raveling of broken stone roads under traffic may be prevented by the application of a hot coat of bitumen. This coat is applied after carefully sweeping the surface and a quantity of from ¼ to ¾ gal. per square yard is used. Such material may be applied by means of a pressure distributor. It is then covered with a layer of ¾-in. stone, and rolled.

During the summer months a broken stone road may become dry and dusty. To prevent this condition arising, it will be necessary to apply oil or light tar to the surface at the rate of about ⅓ gal. per square yard, and then spread sand, screenings or pea gravel lightly over the material, the oil or tar to blot up any surplus and stop the material sticking to the wheels of vehicles. An application of a dust preventive in the early spring and a second in mid- or late summer will render the road dustless during the months of heavy summer traffic.

Crown and Grades.—Broken stone roads are rounded or crowned slightly in order to shed water. The amount of rise given the center of the road should be as little as possible consistent with proper drainage. A slope of ¼ to ½ in. per foot will usually be found sufficient and will give on a road 20 ft. wide a crown 2½ to 5 ins. higher at the center than at the sides. A rise of from 3 to 3½ in. will be found very satisfactory on such a width of road.

On steep grades broken stone roads will be found to give good foothold for horses. In such situations the maintenance cost will be high because of the material washing away. Broken stone roads have, however, been successfully maintained on grades of from 5 to 12 per cent.

Broken stone roads have several advantages, among which may be mentioned, that they do not require rigid or expensive inspection and they can be laid in all but freezing weather. If well built it retains its shape and does not distort or wave or creep, and is an easy riding road for team or motor traffic. The disadvantages of broken stone roads are that if subjected to much traffic in the spring they tend to break up and ravel, while heavy automobile traffic tends to sweep away the dust particles between the large stones leaving a rough surface.

Pennsylvania Highway Work.—Since February, 1919, the Pennsylvania State Highway Department has awarded contracts for 1,000 miles of new roadway. At the present time 769 miles are under contract.

---

*Paper presented at the 7th Canadian Good Roads Convention, Winnipeg.

A Study of the Standard Deval Test for Rock

Results of the series of tests made in the laboratory of the U. S. Bureau of Public Roads in connection with certain proposed changes in the Deval abrasion test for rock are given in a paper presented at the [illegible] annual meeting of the American Society of Testing Materials. An abstract of the paper follows:

The Deval test is probably the best known and most widely used of any of the methods which have been developed for testing the quality of road-building rock. It has been in continuous use in this country for nearly 20 years and, in general, has been considered satisfactory for the purpose for which it was designed: that is, to measure the relative resistance of rock to wear or abrasion. In spite of this fact, however, it must be confessed that the method is weak in at least two particulars.

Variations Due to Laboratory Manipulation. In the first place, experiments made recently have indicated the possibility of a considerable error in results obtained due to variations in laboratory manipulation. For instance, Mattimore in 1917 reported a series of results in which [illegible] tests on a sample of dolomite made in the same laboratory and by the same operator but on different days showed a maximum variation in percentage of wear of 0.9 per cent. A corresponding series of tests on syenite showed a maximum variation of 1.2 per cent. In the same year Reinecke and Clark in a paper before the society reported a maximum variation of 0.6 per cent on 17 duplicate sets of limestone, and a corresponding maximum variation of 0.3 per cent on 7 duplicate sets of igneous rock. In both of the cases cited, care was exercised to insure, as nearly as possible, the use of identical material in all of the check tests. The variations noted are therefore assumed to be due to laboratory manipulation alone.

Discrepancies Due to Hand Breaking of Samples. Results of tests made by the author along the same line are given in Table I. The results shown in the table were obtained from time to time in the course of the routine work of the laboratory of the Bureau of Public Roads and extended over a period of a year or more. No effort was made to specially prepare any of the samples. They were, however, all prepared by the same operator—an experienced man who has been engaged in this work for the past 18 years. These results indicate clearly the degree of accuracy which may be expected in a given laboratory and under average normal conditions. It will be noted that the average maximum deviation for the four types examined amounts to approximately 0.8 per cent. This would correspond, in the case of granite, trap, or other hard rock having, for instance, an average percentage of wear of 3, to a possible variation of from 12 to 16 in French coefficient of wear, or four points. This is rather a serious error and calls for a greater tolerance in interpreting the results of tests than we have been in the habit of considering necessary. The principal reason for the discrepancies noted is the practical impossibility of securing by the ordinary method of hand-breaking a test sample consisting of 50 pieces all of the same size and shape. It is, of course, obvious that variations in either respect will affect the results obtained, particularly if the stone be unusually soft or brittle. The present standard method requires that a sample of rock for the abrasion test shall weigh within 10 g. of 5,000 g. and shall be composed of 50 pieces of freshly-broken stone of as nearly the same size as possible. While no reference is made to the shape of the pieces, the assumption has always been that cubical fragments should be prepared. It has been the author's experience that such a sample is extremely difficult to prepare in the ordinary manner in a reasonable length of time. As a matter of fact, it may be doubted whether it is even approximated in the majority of laboratories.

TABLE I—COMPARATIVE RESULTS OF ABRASION TESTS USING STANDARD AND PROPOSED METHODS

Test No.	Type of Rock	Percentage of Wear by Standard Method: Individual Results			Av.	Max. Deviation	Percentage of Wear by Proposed Method: Individual Results			Av.	Max. Deviation
1.	Granite	4.0	4.3	4.6	4.3	0.6	6.0	5.8	5.7	[illegible]	0.3
2.	Granite	5.0	4.4	4.6	4.7	0.6	6.0	[illegible]	6.1	6.0	0.2
3.	Granite	3.0	3.3	2.9	3.1	0.4	[illegible]	4.1	[illegible]	[illegible]	[illegible]
4.	Trap	2.0	2.7	2.5	2.4	0.7	[illegible]	3.2	3.0	3.1	0.2
5.	Trap	2.9	2.5	2.6	2.7	0.4	4.0	4.1	4.3	4.2	0.3
6.	Limestone	5.9	6.3	6.8	6.3	[illegible]	12.0	12.3	12.4	12.2	[illegible]
7.	Limestone	9.2	10.8	10.6	10.2	[illegible]	29.1	29.0	29.6	29.1	0.6
8.	Sandstone	5.8	6.7	7.0	6.5	1.2	13.1	13.0	13.3	13.2	0.2
	Average					0.8	Average				0.3

New Method of Preparing Samples. Appreciating the need of a more rapid as well as accurate method of preparing samples, the laboratory of the Bureau of Public Roads has been for some time experimenting with a forcing press equipped with suitable knife edges for breaking stone. It was first used by the laboratory in the preparation of granite paving block samples for test because it was found that the variations obtained when specimens were hand-broken were so great that the results were of little value. It has a capacity of 2[illegible]000 lb., which is sufficient to break an ordinary standard-size granite block. By the use of this machine small cubical fragments of the size desired may be prepared conveniently from practically all types of rock with the exception of some traps and the very highly foliated or laminated varieties such as gneiss and schist. With these types it is always a question of doing the best possible with the material in hand. A standard sample prepared in the above manner will consist of 50 pieces, approximately cubical in shape, each of which should weigh from 85 to 115 g. Results of tests on samples of different types of rock prepared in this manner and compared to tests on the same materials prepared in the usual way are shown in Table I and will be discussed below.

Another Criticism of the Deval Test. The Deval test has been criticized also from another point of view. In a paper presented at the 1918 annual meeting of the Society, Scofield called attention to the action of the so-called "dust cushion" on the inside of the abrasion cylinder. He showed that in eliminating this cushion by removing the dust of abrasion during the test, a much greater range in values could be obtained, especially among the softer rock types. Other investigators working along the same line had independently reached the same conclusion. Indeed, the present method is so obviously wrong in principle it is remarkable that it has not been changed before.

In regard to the elimination of this "dust cushion" the author sees no better way than to simply mill a series of longitudinal slots in the standard abrasion cylinder through which the dust may escape as fast as it is formed. The arrangement of the slots has been adopted in the Bureau of Public Roads laboratory. They are 1½ in. apart, center to center, and 1/16 in. wide. The exact spacing or length of the slots, however, apparently makes very little difference in the actual results obtained, provided there are a sufficient number of openings to permit all of the dust to escape.

Several other suggestions in the way of improving this test, such as the use of small shot as an abrasive agent, a graded instead of a one-size sample, etc., have been offered from time to time. Some of these will be briefly discussed in the conclusions to this paper.

Discussion of Results Obtained.—The work covered in the following discussion was carried out, therefore, with two primary objects in view:

1. To determine how variations in the results of tests due to laboratory manipulation may be reduced;
2. To determine the comparative range in values obtained with and without the "dust cushion."

The results of a number of tests made on samples prepared by machine and tested in the slotted abrasion cylinder are given in Table I, and may be compared to the values obtained in the ordinary manner and to which reference has already been made. It will be noted that the average maximum deviation of 0.8 per cent observed with the standard method has been reduced to 0.3 per cent by the use of machine-broken fragments. The individual losses, on the other hand, have been increased in varying amounts due to the elimination of the dust cushion. Tests in the closed cylinder using machine-broken fragments showed slightly lower average results than with the standard method, no doubt due to the absence of wedge-shaped or flat pieces which frequently find their way into a sample prepared in the usual way. The results of a number of tests on a large variety of rock types are given in Table II.

Taking into account the fact that all of the test results given in Table II were obtained on samples hand-broken in the usual way and are liable therefore to a possible error of nearly 1 per cent, the relationship is fairly well defined, and shows clearly the value of using the slotted cylinder in defferentiating between the wearing qualities of the softer types of rock.

In Fig. 1 are plotted the results of a number of tests made in both the standard and slotted abrasion cylinders in which the loss by abrasion was determined at the end of each 1,000 revolutions. A comparative run was made also in each case using six 1⅞-in. cast-iron shot as an abrasive agent. These tests were made in order to determine the practicability of accelerating the wear by means of an abrasive and at the same time speeding up the test by cutting down the total number of revolutions. According to the results shown in the figure it would appear theoretically possible to obtain about the same loss at the end of 2,000 revolutions when shot are used as would be obtained at the end of 10,000 revolutions without the abrasive. As a matter of fact, however, experiments have shown that the gain in time thus effected would be more than counterbalanced by the resulting loss in accuracy. It has been found impossible to obtain check tests closer than 1 per cent when an abrasive is used, due probably to the breaking up of the fragments composing the sample under the action of the shot. This action makes the test a measure of toughness rather than of resistance to wear. Inasmuch as the amount of this action would depend to a large degree on the prevalence of incipient fractures or minute seams in the rock which would not affect the value of the material in road construction, the use of an abrasive is not recommended. The effect of these minute fractures which frequently can not be detected by the eye has been noted in connection with the standard test for toughness of rock.

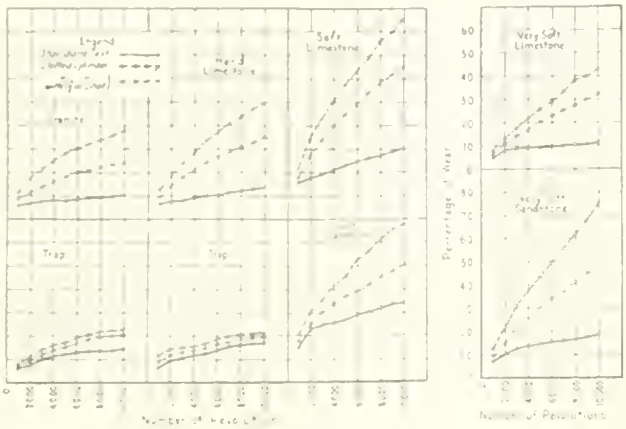


Fig. 1—Chart Showing Relation Between Percentage of Wear and Duration of Test.

TABLE II—RESULTS OF COMPARATIVE ABRASION TEST FOR ROCK.

No.	Type of Rock.	Hardness.	Toughness.	% of Wear Standard Test	% of Wear Slotted Test.	Difference.
1.	Trap	18.7	35	1.6	2.4	0.8
2.	Trap	18.7	..	2.0	2.4	0.4
3.	Trap	18.0	22	2.0	3.0	1.0
4.	Granite	19.0	10	3.2	3.5	0.3
5.	Trap	18.5	43	3.0	3.8	0.8
6.	Trap	17.3	21	2.7	3.9	1.2
7.	Trap		..	2.7	4.0	1.3
8.	Granite	18.0	14	3.4	4.0	0.6
9.	Granite	18.7	10	3.7	4.2	0.5
10.	Granite	18.0	14	3.2	4.2	1.0
11.	Trap	18.0	26	2.3	4.2	1.9
12.	Granite	18.0	9	3.6	4.2	0.6
13.	Granite	18.7	13	3.3	4.3	1.0
14.	Granite	18.7	10	3.5	4.4	0.9
15.	Quartzite	18.7	16	3.4	4.5	1.1
16.	Granite	18.7	9	3.4	4.5	1.1
17.	Granite	18.7	10	3.5	4.5	1.0
18.	Trap	18.0	20	2.8	4.6	1.8
19.	Granite	19.3	11	3.6	4.7	1.1
20.	Granite	18.[illegible]	10	3.4	4.7	1.3
21.	Granite	18.0	10	3.8	5.0	1.2
22.	Quartzite	18.7	17	3.3	5.1	1.8
23.	Limestone	17.2	15	3.5	5.1	1.6
24.	Limestone	17.3		3.3	5.6	2.3
25.	Granite	16.7	8	3.2	5.6	2.4
26.	Granite	17.3	7	4.2	5.6	1.4
27.	Trap	18.[illegible]	18	3.2	5.8	2.6
28.	Granite	17.[illegible]	7	4.2	5.9	1.7
29.	Granite	16.7	8	4.3	5.9	1.6
30.	Granite		7	4.4	5.9	1.5
31.	Granite	18.0	9	4.3	6.0	1.7
32.	Granite	16.7	8	4.5	6.1	1.6
33.	Granite	18.0	8	5.2	7.2	2.0
34.	Limestone	15.0	10	6.4	7.7	1.3
35.	Sandstone	16.7	8	4.3	8.0	3.7
36.	Trap	16.7	9	4.0	8.6	4.6
37.	Limestone	17.[illegible]	15	4.8	8.8	4.0
38.	Limestone	12.[illegible]	6	3.3	9.3	6.0
39.	Limestone	16.0	8	6.0	10.2	4.2
40.	Limestone	12.3	6	4.7	10.4	5.7
41.	Limestone	[illegible]	8	5.3	10.6	5.3
42.	Granite	18.[illegible]	6	6.8	10.6	3.8
43.	Limestone	[illegible]	[illegible]	5.4	10.7	5.3
44.	Limestone	17.0	[illegible]	5.9	11.1	5.2
45.	Limestone	16.[illegible]	6	6.8	11.4	4.6
46.	Limestone	[illegible]	6	7.0	11.7	4.7
47.	Limestone	12.1	[illegible]	6.2	12.2	6.0
48.	Limestone	[illegible]	[illegible]	7.0	12.2	5.2
49.	Limestone	[illegible]	4	5.9	12.9	7.0
50.	Limestone	[illegible]	[illegible]	[illegible]	13.0	7.1
51.	Limestone	[illegible]	[illegible]	[illegible]	13.4	5.1
52.	Limestone	14.0	[illegible]	[illegible]	13.8	6.8
53.	Limestone	12.0	[illegible]	[illegible]	16.8	9.4
54.	Limestone	10.[illegible]	[illegible]	[illegible]	19.1	12.2
55.	Limestone	[illegible]	[illegible]	8.[illegible]	22.9	14.4
56.	Limestone	8.0	[illegible]	[illegible]	27.6	16.8
	Limestone	[illegible]	[illegible]	10.8	31.4	20.6

The following conclusions may be drawn:

1. Results of the standard Deval abrasion test as conducted in the usual way are accurate to within one per cent.
2. The difficulty of properly preparing samples by hand in a reasonable length of time is the principal reason for the discrepancies in results observed.
3. Samples may be prepared conveniently and accurately by means of the machine described in this paper.
4. The range in values of percentage of wear is greatly increased by the use of a slotted cylinder which permits the dust of abrasion to escape as fast as it is formed.
5. In general, the difference between percentage of wear as determined in the standard and in the slotted cylinder increases as the coefficient of hardness of the rock decreases.

In conclusion, the author would strongly recommend that Committee D-4 on Road Materials consider the modifications of the Deval abrasion test outlined above in connection with the proposed revision of the standard method.

Pennsylvania Highway Department Uses Lodometers for Determining Weight of Truck Loads

Inspectors for the Automobile Division of the State Highway Department of Pennsylvania and state policemen are equipped with lodometers, or "jack scales." With these machines it is possible to get the approximate weight of trucks. The lodometer is a mechanism with a jack attachment and is placed under the axles of trucks suspected of being over weight. Two lodometers are placed first under the rear axle, which is then jacked up. The dials on the lodometers give the weight carried on the rear end of the truck. Then the lodometers are moved to the front axle and that end is raised. The total weight registered front and back gives the approximate weight of truck and load. Under the state law trucks must have painted on the outside the maximum weight limit permitted by the manufacturer of the car. If the lodometers show that this weight limit has been exceeded the inspectors take the truck to the nearest scales where an exact weight is secured.

Under the law no commercial vehicle may carry a weight greater than that specified by the manufacturer. It is on this point that arrests are now being made throughout the state. The automobile division inspectors find that the greatest loads are being carried after dark; and they report steady streams of huge motor vehicles constantly plying between New York and New Jersey points and Philadelphia. The fine for over-loading trucks is from $25 to $100 and in addition costs are levied, or a six months' jail sentence may be imposed. The fine goes into the treasury of the municipality in which the arrest is made.

The department's lodometers in future will be in continuous use throughout the state and trucks will be stopped and weighed on the highways.

Under the state law commercial vehicles are divided into seven classes. The maximum weights allowed for these classes, including chassis, body and load, are as follows:

Class AA, 7,000 lb.; class A, 11,000 lb.; class B, 15,000 lb.; class C, 20,000 lb.; class D, 24,000 lb.; class C and F, 26,000 lb.

No commercial vehicles may travel at a rate of speed in excess of that shown in the following table:

Class AA, 20 miles per hour; class A, 20 miles; class B, 18 miles; class C, 15 miles; class D, 15 miles; class E, 12 miles; class F, 10 miles.

Asphaltic Concrete Pavements*

By W. H. CONNELL

[illegible]

Nine-tenths of the highway problem [illegible] been the upkeep. The [illegible] really the whole problem after the [illegible] been selected and provision made [illegible] comes first and drainage comes [illegible] provision has been made for the[illegible] the question is what kind of road [illegible] built in this particular locality [illegible] social and local conditions.

It would be perfect nonsense [illegible] down asphalt concrete, or concrete [illegible] where there will not be enough [illegible] pavement in a great many years. [illegible] tom and build up gradually. First, [illegible] gravel road, then macadam roads, then [illegible] face treated. Then come penetration [illegible] asphaltic concrete on a macadam [illegible] asphalt on a concrete foundation, then [illegible] then the brick, and last but not least, [illegible]

Surface Treatment and Patching Macadam. [illegible] a great many engineers in different localities [illegible] day of macadam has gone by, that macadam [illegible] up under present day traffic in localities where [illegible] considerable motor traffic. It will stand up and [illegible] under automobile traffic, if given surface treatments as frequently as are required. Surface treatments should be applied to macadam roads under some conditions every year and under other conditions every two years or three years, depending on the amount of traffic.

I recently went over a number of roads in Pennsylvania where there are a great many good roads of all descriptions with a number of engineers, and they said "we have come to the conclusion that we are going to lay off these roads and let them all go, all gravel, and macadam, until we can afford to put down one of the more or less permanent types of pavement." That policy will result in an unwarranted waste of money.

We have proved right in New York City and for some of the heaviest traveled roads in Philadelphia that one can take an ordinary broken stone road and keep it almost indefinitely at a very modest cost, if it is given constant attention. Keep the surface treatment on it. Patch the road, and give it the day-to-day attention that anything else in the world requires if it is to be kept up, and the road will give first class service until the time when it is going to be turned over to very heavy motor truck traffic.

I resurfaced a macadam road in New York City, the Grand Boulevard and concourse, the main highway leading out from the Bronx to Boston, with from 10,000 to 12,000 automobiles a day travelling over it. It was built in 1910. We did not have any pressure means for putting down our surfacing material, but used the old crude method of the watering can. It was macadam surfaced with tar. That road has been kept up and treated as often as required and is in perfect condition today, and was when I saw it a few weeks ago. That is an illustration of what can be done with materials at hand.

Importance of Solid Sub-Base.—The great trouble we are having today is that we lay a 6-in. concrete road on a new sub-base where there has been no road before. Concrete will not crush under traffic. In New York City about two years ago they made an investigation at my request to find out if the concrete did crush under the heaviest traffic they had in the city, and they found that it never did crush or give under traffic.

A great many say that 6 in. of concrete will not stand very heavy motor traffic. They miss the point. The concrete stands, but the sub-base under the concrete goes with the traffic and that breaks the concrete. If you build your road, and it is desirable to put a road in [illegible] built it up on materials that you have at hand, and let the traffic keep going over it for years and when the time comes to put on your concrete, you will have a perfectly firm and solid sub-base that will enable you to keep your road under the heaviest possible traffic, because 4 or 5 in. of concrete will stand up if the sub-base is sufficiently solid.

Special Roads for Motor Trucks.—The time [illegible] to my way of thinking, when between the big [illegible] [illegible] the [illegible] truck [illegible] width of the [illegible]

I was asked [illegible] the [illegible] [illegible] to [illegible] on that subject and I told them that the time was coming, and [illegible] when we shall have steel tracks for our heavy motor truck traffic, paved with granite block in between and on the shoulder, to carry the large trucks between such cities as New York, Philadelphia, Baltimore and Washington.

We cannot build a road to carry the kind of traffic that passes through a park that will also carry the kind of traffic expected over an intercity freight motor truck road. It would be a waste of money to build a road for such heavy motor truck traffic where probably 80 per cent of the traffic is passenger automobile traffic. We should be building a very expensive type of road to carry the 20 per cent traffic, one that would be entirely unnecessary for the 80 per cent.

Asphaltic Concrete Pavements. There are two ways of building asphalt roads, namely, on a macadam foundation or on a concrete foundation. If your build your roads now on proper location and with proper drainage and plenty of [illegible] and when gravel is required you put it on, then when the time comes to put on an asphaltic concrete, you will have a foundation that you can lay the road on, provided it is a traveled road. I believe that if you put the asphaltic concrete road on a broken stone foundation or on a gravel foundation that has been traveled over, so that it is thoroughly compact, you really get better results than if you put it on concrete. Concrete will crack. We cannot stop it from cracking, and the pavement will crack right through to the surface. That of course does not injure the pavement seriously. You can bind up those cracks with a little bituminous material, but you are not likely to have that trouble on an old macadam or gravel road.

An asphaltic concrete that we have built successfully, is the one that is covered by the Warren patent, and that is about $7\frac{1}{2}$ per cent of asphalt, 8 to 10 per cent of limestone or Portland cement dust, 50 to 55 or 60 per cent of stone and 25 to 30 per cent of sand, all properly graded. I have laid several hundred miles of that type of pavement, but laid it in the locations where the patent did not affect us, and we were not disturbed. That is the best asphaltic concrete pavement.

The second is that known as the Topeka pavement. In that you put a moderate percentage of asphalt, about 8 or 9 per cent, because you use a small-size stone, about a quarter of an inch, and you also use a different grade of sand. We have had very satisfactory results with it. In an inspection tour I made recently, I particularly noted the results of the wear of heavy motor truck travel over the various types of pavement. The asphaltic concrete has stood up as well as any one of the types of pavement I speak of, and has given the service that we expected it to give, and in my classification of pavements I put it ahead of concrete, that is if it is on an old broken stone road or on a concrete base.

This statement would probably be disputed by a great many people, because concrete seems to the layman better than anything else, because he does not know anything about it except in a superficial way. The simplest thing to a layman's mind is concrete. Concrete roads are good roads, but you cannot build them that they won't crack. If you can do that there are untold millions waiting for you.

A concrete road after it is laid must be maintained like any other road, and it is usually maintained by being patched and [illegible] with tar and asphalt poured into the joints, resulting in a very ugly looking pavement, to my mind not suitable for a park or a city.

The asphaltic concrete pavement on a firm base will give just as good wear as a concrete road and is a very pleasant type of pavement to look at. It harmonizes with the surroundings. You do not have those ugly cracks staggering all over the road and staring you in the face, and you have a road that is very desirable for automobile traffic. [illegible] slippery for horse-drawn traffic and one that, as I said before, will last and give you the service, as has been proved.

---

*From [illegible] paper presented Jan. [illegible] at the [illegible] Roads Convention.

In our part of the country, we have kept very close watch on paving costs, and, judging from our experience, the roads that stand out as the most economical for ordinary traffic, not for the very heavy motor truck traffic that exists between cities on some roads, but for roads accommodating from 10,000 to 16,000 automobiles a day, mostly passenger cars and a few motor trucks, those that are the most economical to build and maintain are of asphaltic concrete. The concrete truck road gives service and does not require very extensive repairs, but it costs much more to build it, and it does not prove to be so economical as the other type.

Condition of Philadelphia Service Test Road. I was asked to say a word or two about the service test road built in Philadelphia in 1912, consisting of 28 different types of construction. This was very conscientiously maintained until the United States got into the war. One section was asphaltic concrete laid cold, that is an asphalt cut back and mixed in the plant and then hauled out to the road, laid cold and rolled. It is a very satisfactory type of road for ordinary park motor traffic, but it is not so good as the hot asphaltic concrete and will not stand heavy motor traffic. A number of different types were put on this road without considering whether they were types of pavement suitable for the particular traffic existing there, and in analyzing the results obtained, if one style of pavement did not last in that section of road in which it was laid, it should not be condemned. They were analyzed according to the traffic they will stand. The roads that stood up the best were of brick. They are there today, and have not had one cent of repair, but they cost twice as much to construct as the concrete and asphaltic concrete.

One section of the asphaltic concrete, coming under the specification I have just noted, of 55.60 per cent of stone passing through a 1½-in. or 1¼-in. grade and 7½ per cent of asphalt, has not had any repair. Another section of the road, with the same specification, had only cost 2 ct. a yard, on an average to maintain for seven years. The pavement laid with the smaller stone, the so-called Topeka pavement, has cost only 5 or 6 ct. a yard to maintain for the same period of years.

All the pavements stood up with practically no repairs until the fall of 1917. Up to that time the traffic was the ordinary motor truck traffic with a larger percentage of passenger cars. When we got very active in the war, that particular road was part of the Lincoln Highway and was the main motor truck road to New York and Philadelphia. There were then streams of motor trucks passing over it day after day. And when that started, all the sections laid by the penetration method failed. The traffic was too heavy for them. They were not intended for the heavy pounding of motor trucks. As I say, up to 1917, when this extraordinary motor traffic bgean all the different types of pavement stood up well, including the macadam with surface treatment, but when the motor truck traffic came on, the only ones that stood up were the brick and asphaltic concrete, and the concrete.

Cost of Iowa Gravel Deposits. Average Iowa gravel deposit land, with pit run material suitable for gravel road building and, when cleaned and screened, suitable for use in road and bridge concrete, is selling at from $300 to $500 per acre, according to the May-June Service Bulletin of the Iowa Highway Commission. One county has purchased one especially valuable gravel pit at the rate of $2,000 per acre; a few others have made purchases at the rate of $1,000 and about an equal number have made purchases at $200 per acre. The $2,000 price stands as a maximum and $160 as a minimum in reports upon 64 purchases of gravel deposits by 32 individual counties. The distance of these pits from railroad stations runs from location adjacent to the station to 10 miles. The majority of the pits are within an average of possibly three miles. In cases where counties have contracted to pay by the cubic yard, the price has ranged from 10 ct. as a minimum to $1.50 as a maximum. Johnson county is paying $1.50 per cubic yards upon occasional orders; Bremer, 70 ct. for material from one deposit and 50 ct. from another. These prices for certain reasons are higher than the general average, which would seem to be in the neighborhood of 20 ct. to 30 ct.

Proposed Methods for Sampling Stone, Gravel and Sand for Highway Use

In its report presented at the 23rd annual meeting of the American Society for Testing Materials, the Committee on Road Materials, of which Prevost Hubbard, 25 W. 43rd St., New York City, is Secretary, outlined methods for sampling stone, slag gravel, sand and stone block for use as highway materials, which it recommended should be published as tentative before being referred to letter ballot of the society for adoption as standard. The committee felt that standardization of sampling the above materials was very desirable, but that it was extremely difficult to cover adequately every condition likely to be encountered, particularly in the matter of sampling natural deposits. The proposed tentative methods are described as follows in the report:

Samples of all materials for test upon which is to be based the acceptance or rejection of the supply shall be taken by the engineer or his authorized representative. Samples for inspection or preliminary test may be submitted by a producer or owner of the supply.

Sampling of Stone from Ledges or Quarries for Quality.—The ledge or quarry face shall be inspected closely to determine any variation in different layers. Any difference in color or structure shall be observed, and if necessary to secure unweathered specimens, pieces broken from different layers.

For standard stone test, separate samples shall be taken of at least 30 lb. each of fresh unweathered specimens from all layers that appear to vary in color or structure. When more than one piece is taken, the minimum size shall be 2 in., except that there shall be one piece of each sample of a minimum size of 4 by 5 by 3 in. on which the bedding plane is marked and which shall be free from seams or fractures to be used in the toughness or compression test.

The sample for concrete test will depend on the kind of tests to be made and the number of specimens necessary.

In addition to the general information accompanying all samples, samples from local ledges not commercial sources shall contain the following: Name of owner; approximate quantity available (if quantity is very large this can be recorded as practically unlimited); amount and character of overburden or stripping; haul to nearest point on road where the material is to be used; character of haul (kind of road and grade); also some detailed record of the extent and location of the material represented by each sample. For this purpose a sketch, plan and elevation showing the thickness and location of the different layers is recommended.

Sampling of Stone from Commercial Quarries.—Where practical, samples from commercial quarries shall be taken from the ledge or quarry face and the same procedure shall be followed as when sampling local ledges.

At the plant, the following factors affect the size of broken stone: Size and shape of screen openings; length of screen sections; the angle of screen with horizontal; the speed of screen rotation; and the rate at which the screen is fed. A general inspection and record of these conditions shall be made. The sample shall be taken preferably from cars or boats while loading from stock piles or bins. It is recommended, in order that the sample may be representative, that separate samples be taken at different times while the material is being loaded. If the sample has to be taken from the bin or stock pile, several samples shall be taken from different parts of the stock pile and from the top of the bin and the loading chute. These separate samples shall be well mixed in a composite sample and the sample for test obtained by the quartering method.

Where it is not practical to visit the plant, samples for both quality and size shall be taken from different parts of the car or boat during unloading. It is recommended that separate samples be taken from the top, middle and bottom of car or boat. These separate samples shall be well mixed in a composite sample and the sample for test obtained by the quartering method. The results of tests on crushed stone for quality are not considered comparable with results from samples specially broken for test in the laboratory, but the general quality of the stone can be ascertained and check tests on various shipments should indicate any change in quality. In this case, tests for both quality and size can be made on the same sample.

Where test is to be made for size only, it is recommended that a small set of screens and a pair of scales or some unit measure receptacle for measuring volume be used for field testing in order not to delay decision on the use of the material. Occasional check tests can be obtained from the laboratory to assure a fair degree of accuracy in field testing.

The sample of crushed stone for mechanical analysis shall weigh at least 50 times the weight of the largest piece therein.

The sample for concrete test will depend on the kind of tests to be made and the number of specimens necessary.

Sampling of Field Stone and Boulders.—A detailed inspection of the deposits of field stone and boulders over the area where the supply is to be obtained, shall be made. The different kinds of stone and its state of preservation in the various deposits shall be recorded.

Separate samples shall be taken of all stone of different classes that a visual inspection indicates from state of preservation and degrees of lamination, should be considered for use in construction.

Records accompanying samples of field stone and boulders in addition to general information, shall contain the following:

Location of supply;

The plotting of the field stone and boulder [illegible] on a topographic or a similar map is recommended for this purpose.

Approximate quantity available:

A fairly accurate estimate of amount of stone in fences can be made by measuring a cross-section and pacing the length. It is more difficult to estimate the amount of stone scattered over the ground and ordinarily such deposits do not pay to work under [illegible].

Information regarding the percentage of different classes of stone which were sampled and the percentages of material which can be rejected by visual examination and may have to be handled and spoiled.

This information regarding the percentage of different kinds of material can only be estimated and the degree of accuracy attained will depend almost entirely upon the experience and skill of the individual.

Sampling of Blast-Furnace Slag.—It is recommended that blast-furnace slag be sampled for size and quality by the method specified for broken stone.

Sampling Sand and Gravel—Non-Commercial Deposits.—Non-commercial as used here includes all undeveloped sand and gravel deposits and all developed deposits where the material is not washed or screened.

The investigator should realize that few if any natural sand and gravel deposits are uniform, and when a sample is taken the quantity of material in the deposit similar to the sample shall be ascertained as nearly as possible.

Where possible, samples of sand shall be taken when it is in a damp condition.

If the deposit is worked as a bank or pit and has an open face the sample shall be taken by channeling the open face so as to represent material that visual inspection indicates could be used. Care shall be taken to eliminate any overburden or stripping at the top or any that has fallen along the face from the top. It is necessary, especialy in small deposits, to excavate test pits some distance back of and parallel to the face to determine the extent of the supply. The number and depth of these pits depend on the quantity of material that is to be taken from the deposit. Separate samples shall be taken from the face of the bank and from test pits. These shall be well mixed in a composite sample and the sample for test obtained by the quartering method.

Deposits that have no open face shall be sampled by means of test pits. The number and depth of these will depend on local conditions and the amount of material to be used from the source. A separate sample shall be taken from each pit and where visual examination indicates no radical difference in size of grain, color, etc., these shall be well mixed in a composite samples and the sample for test obtained by the quartering method. Where visual inspection indicates a distinct difference in material from different pits, separate samples shall be taken for test.

It is suggested that the colorimetric test be used for determining the percentage of organic material[1].

In addition to the general information accompanying all samples from sand and gravel deposits not commercial sources the same [illegible] with samples of stone taken from [illegible] ledges.

Sampling of Sand and Gravel from Commercial Plants.—Samples of both sand and gravel from commercial screening or washing plants shall be taken from the bins or storage piles preferably while the material is being loaded from these supplies. The sand and gravel should be sampled as separate units and shipped as such. It is difficult to secure a representative sample from stock piles and bins and, if conditions require sampling from these sources the following is recommended. Separate samples shall be taken from different parts of the stock pile, care being taken to avoid sampling a segregated area of coarse-grained material which is likely to exist at the base of the pile. In sampling from a bin, separate samples shall be taken from the top and the loading chute. At the latter place at least ½ cu. ft. of material shall be run off and representative samples taken from it. These separate samples shall be well mixed in a composite sample and the sample for test obtained by the quartering method.

The size of sand and gravel will be affected by the same factors as broken stone and the same inspection is necessary. In addition, the relative amount of water used in screening must be taken into consideration. The same procedure for taking a sample of broken stone for size is recommended for sampling sand and gravel for size, both at plant and at delivery.

Where it is not practical to visit the plant, samples for both quality and size shall be taken from different parts of the car or boat during unloading. It is recommended that separate samples be taken from the top, middle and bottom of car or boat. These separate samples shall be well mixed in a composite sample and the sample for test obtained by the quartering method.

Quantity of Sand and Gravel Samples.—Samples of run of bank (where the sand and gravel are combined) shall consist of at least 100 lb. of material where the gravel content is 50 per cent or more of the whole. If the gravel is less in percentage, the sample shall be increased in proportion. For example, where the gravel percentage is 25 per cent of the whole the sample should contain 200 lb.

Samples of sand shall contain at least 20 lb. of material.

Samples of gravel shall contain at least 50 lb. of material.

The sample for concrete test will depend on the kind of tests to be made and the number of specimens necessary.

Sampling of Miscellaneous Materials.—Samples of slag, sand, screenings, mine tailings, and all other materials used as a substitute for sand and gravel or broken stone, shall be inspected in the same manner and samples taken in the same way as the materials for which they are substituted.

Sampling of Stone Block.—Samples shall be taken either at the quarry or from cars or boats as directed by the engineer. They shall be representative of the block which it is proposed to use and no sample shall include blocks that would be rejected by visual inspection.

The sample shall consist of at least six blocks and the bedding plane shall be marked on at least two of these.

General Directions for Shipping and Marking Samples.—Samples of ledge stone, crushed stone and slag shall be shipped in a secure box or bag.

Samples of stone block shall be securely crated.

Samples of run of bank gravel, sand screenings and other fine material, shall be shipped in a tight box or closely woven bag so there shall be no loss of the finer particles.

Each sample or separate container shall be accompanied by a card or regular form, preferably in the container, giving the following information: By whom taken, official title or rank of the sampler, by whom submitted; source of supply; proposed use for the material; and in case of commercial supplies, daily production; geographic location, shipping facilities (name of railroad, canal or river, or other common carrier); and price of the material.

Township Road Work in Pennsylvania.—During the years 1917, 1918 and 1919 second-class townships of Pennsylvania counties collected $26,551,297 for road purposes. Under the law township supervisors fix a tax rate for road purposes. The moneys thus collected are spent for the upkeep, repair, or reconstruction of township roads. In 1917 the total sum collected by the townships was $6,122,812. In 1918 it had increased to $8,972,190. The increase continued in 1919, when the total sum collected by the townships of Pennsylvania reached $11,456,294.

---

[1] For a description of this test, see Proceedings Am. Soc. Test. Mats., Vol. XIX, Part I, p. 321 (1919) also, Vol. XVII, Part I, p. 327 (1917).

Labor Saving Machinery on Minnesota Road Contract

In constructing Minnesota Federal Aid Project No. 31, the contractors, A. Guthrie & Co. of St. Paul, are making extensive use of machinery. This project involving the building of 9 miles of standard 1 course, 1:2:4 mix, concrete pavement, is divided into two sections, one extending 3 miles east from the city limits of Willmar, Minn., and the other 6 miles west from the town. The pavement is laid 18 ft. wide, 7½ in. thick at the center and 6½ in. thick at the sides. An interesting description of the plant used on this job, with data on its operation, is given by Mr. Geo. C. Scales, Senior Highway Engineer, U. S. Bureau of Public Roads, in "Public Roads," a publication of the Bureau, from which the notes in this article are taken.

The road was graded in 1918 so that the contract awarded to A. Guthrie & Co. involves subgrade work only to the extent of the shaping up of an existing subgrade and laying some drain tile. The main part of the contract involves the placing of 94,491 sq. yd. of concrete pavement, for which the price bid was $2.44 per square yard.

The road is practically level, but there are occasional grades, the maximum being 2½ per cent. The Great Northern Ry. parallels the project for approximately a mile, and to facilitate the construction work a siding and unloading plant have been located about a mile from the east end of the project. Here the usual storage space has been provided and a construction camp established.

Features of Unloading Plant.—The extensive utilization of machinery which has characterized the whole work began with the unloading plant. This consists of a stiff-leg derrick, which is provided with an exceptionally long boom. The derrick is so placed that the boom can readily drop the material taken from the cars over an extensive storage area or into a stone bin erected on the opposite side of the track. By the use of a derrick of this type it is possible to reduce the bin capacity so that the cost of loading bins is comparatively small.

The bin is of standard construction, about 40 ft. long, 8 ft. wide, and 12 ft. deep, and was elevated far enough above the ground to provide for gravity discharge. The length of the bin is so divided that one-third of the space is reserved for sand and two-thirds for gravel; six chutes are provided, so that as the industrial cars are spotted for loading six of the buckets which they carry can be loaded at one time. In these respects the bin, as erected, is normal.

The rest of the equipment at the unloading plant consists of the usual water tanks, pumps, boilers, etc. A ½ cu. yd. clamshell bucket is used in unloading the cars and in moving material from the stock piles to the bins. A cement storage shed of 3,000-sack capacity is also provided. There are no unusual features in any of these items.

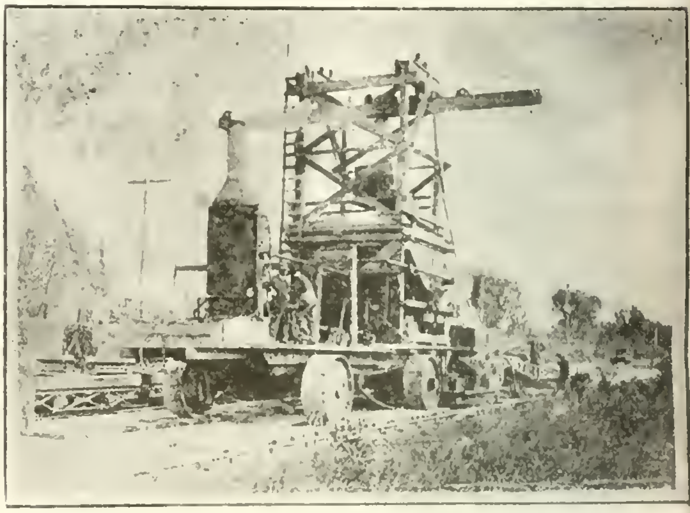
To operate this plant one derrick operator, a fireman, and two laborers, are employed. It has been found in practice that from 15 to 20 cu. yd. of aggregate can be handled per hour. The maximum performance with this crew has been 200 cu. yd. in one 10-hour shift. After making full allowance for all costs, such as the erection of the plant, depreciation, and interest charges, the cost of unloading material from the cars in which it is received and placing it aboard the cars on which it is hauled to the mixing plants is about 50 ct. per cubic yard. This cost may be subdivided as follows:

Labor 27½ ct.; coal, oil and waste 7½ ct.; interest and depreciation 15 ct.; total, 50 ct.

Moving the Materials from Unloading Plant to Mixer.—All materials are moved from the unloading plant to the mixing plant on a standard 36-in. industrial railroad track. The equipment used consists of three 16-ton engines and 21 flat cars and a full set of steel-bottom dump buckets of 35 cu. ft. capacity. The rails used in the industrial track are standard 16-lb. rails. They are laid on 4-in. by 6-in. by 5-ft. hewed pine ties, 14 ties to each rail length. The laying of the track cost about $350 per mile and taking it up for relaying costs about $175 per mile.

These comparatively low costs are, of course, made possible by the fact that the track is laid on the shoulder of the highway, which made it possible to place the track with almost no expense for preparing the subgrade. On the other hand, the liberal use of ties, though somewhat expensive, is fully justified by the fact that it facilitates track alignment and reduces the labor of maintenance. During the progress of the work no time has been lost on account of derailments or other difficulties chargeable to the condition of the track.

The standard train consists of seven cars, one of which may be loaded with cement, two with sand, and four with broken stone. This loading has not always been used, the cement having very generally been sent out a trainload at a time, a method of handling it which seems better suited to this particular job. The process of loading trains is standard for this class of equipment. The empty train is backed to the bins and so placed that six of the material buckets, of which each flat car carries two, are in position under the chutes. After these are loaded the train is shifted to a position which permits of the filling of the remaining buckets. The operation of loading a train takes about 5 minutes.



Traveling Storage Bin for Sand and Stone at Mixer.

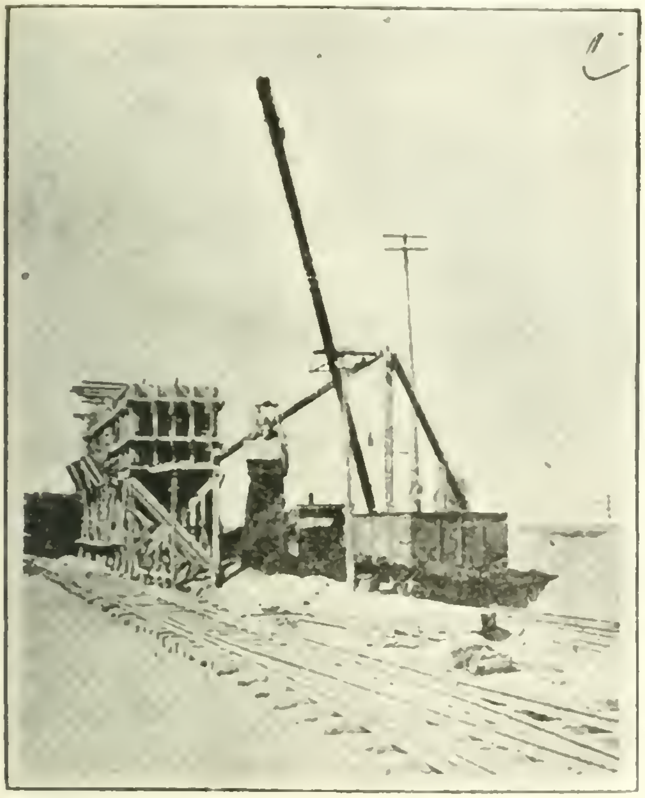
On this project it has been found that with two trains operating over a 6,000-ft. haul and laying about 300 lin. ft. of pavement per shift, the trains are idle about 30 per cent of the time. No time has been lost on account of accidents. From this it is calculated that the material needed at the mixing plant can be supplied by two trains as long as the haul remains less than 2 miles, and that three trains will serve the mixing plant at a distance of 3 miles from the bins. On this particular project, as the grades are light, it is probable that three trains can serve the mixer at a considerably greater distance than 3 miles, for trains of the length here noted as standard can be operated on a 6 per cent grade, so of course, where the grades are as nearly level as they are on this project longer trains would be more feasible than additional trains.

Operating the Trains.—Under the operating conditions prevailing on this project it has been found that a locomotive consumes about 1,000 lb. of coal per locomotive shift. The crew consists of one locomotive driver and one brakeman per train, and operated in this way, including the cost of laying, maintaining, and moving the track, as well as all depreciation and interest charges on the equipment used, the cost of handling aggregate is about $2 per cubic yard for a 3-mile haul. In the nature of the case the cost can not be reduced greatly for shorter hauls. It would be somewhat increased by longer hauls.

One of the most important features in the operation of equipment of this kind is the placing of the switches. On this project the switches are placed about a mile apart. It is doubtful, however, as to whether this practice will prove to have been as economical as the practice of adjusting the position of the switches to the time required in loading, unloading, and moving the trains. There is, of course, a distinct difference in the manner in which the trains must be operated on different projects, depending principally on the methods used in loading and unloading the number of cars on hand. If cars enough are available so that an empty train can be left for loading and a train of loaded cars taken out at once, the standing time of the engine at the loading bins is reduced and the proper position of the switches correspondingly modified. In any event, an arbitrary location of the switches is usually undesirable, as it tends to increase the standing time of the trains. A more advisable practice would seem to be to calculate the average time of loading, the average time of unloading, and the running time between loading and unloading points and regulate the position of the switches accordingly.

Traveling Storage Bin.—The unusual feature of the equipment used on this project is the traveling storage bin designed to serve the mixer. This bin, or bins, for there are two compartments, are built on a large platform carried on four wide-tired wheels, the combined storage capacity of the two bins being 12 cu. yd.

Over the bins there is erected a travelling crane consisting of a light hoist which runs on a heavy beam supported over the bins, and which is operated by means of an engine and drums carried by the platform. By means of this device the buckets delivered over the industrial railroad tracks are lifted off the cars, placed over the bins, and dumped, the coarse aggregate into one bin, the fine aggregate into the other. On the platform also are the propelling engine and an upright boiler which furnishes steam for the hoisting and propelling engines and for the mixer engine as well.


Sand and Stone Storage Bins and Crane and Basket at Railroad Siding.

The bins discharge directly into the loading skip of the concrete mixer. This loading skip is divided into two compartments, one of 6 cu. ft. capacity for sand and the other of 12 cu. ft. capacity for stone. These compartments are filled by opening ordinary gates in the bins of the traveling platform. The process is therefore extremely simple and the accuracy of the measurement easily gaged. Cement is placed in the skip by hand from a flat car alongside the mixer.

The concrete plant and its operation are standard, and therefore require no comment. All finishing work is done by a mechanical tamper of standard make and design.

Comparison of Labor Results Possible. This plant is interesting not only in its design, but because the manner in which the materials are handled makes possible an exact comparison between the force employed and that which would have been required had old hand-labor methods been employed. Thus on this job the moving platform replaces wheelbarrow loading; transportation of materials by industrial railway is substituted for the more common transportation by team or truck; unloading materials with a crane replaces the older methods of hand labor, and the force at the mixer is directly comparable with the operating force ordinarily employed in handling materials, manipulating the mixed material, setting forms, etc. On this project the crew at the mixer consists of a hoisting engineer, a fireman, 1 mixer engineer, 1 man on the sand and stone chutes, 2 men handling cement, 2 men spreading concrete, 1 man operating the finishing machine, 4 men employed in removing forms, watering pavements, etc., and 2 men setting forms, making a total crew of 1 foreman and 15 men. This crew, as suggested above, is directly comparable with the standard crew employed where no loading devices are used, and the saving in labor offers a direct measure of the value of this method of handling materials.

The equipment has worked satisfactorily when the subgrade is dry, but in this particular case the heavy load concentrated on the four wheels of the traveling bins has been too heavy for easy manipulation after the subgrade has been saturated by a number of days of continuous rain. To avoid this difficulty, it is suggested that somewhat smaller hoppers might be more advisable, and that it would also be advisable to distribute the load on a larger number of wheels, thus reducing the unit load so that the subgrade would not be rutted as the hoppers are moved forward.

The advantages of this method of operation, aside from the general advantages which have been noted, are that it eliminates storage of materials on the subgrade and thus preserves the materials in better condition for use, and that it prevents, to a degree, the rutting of the subgrade, which is an inevitable concomitant of delivery of materials by team or motor truck. As tending to offset these advantages there is, of course, the cost of constructing the traveling platform and of moving it over the highway, which will, it is suggested, be largely, if not entirely, eliminated wherever the grades are steep. It would therefore seem that this method, though interesting, and on this project successful, should be adopted only after a careful consideration of the conditions which will be met on other projects, and that it will be found to be inapplicable wherever adverse grades of more than 2 or 3 per cent are to be encountered.

The project, as noted above, is being constructed by A. Guthrie & Co., of St. Paul, with A. Lizee, superintendent in actual charge of the work. H. L. Wardell is the county engineer in charge of the work for Kandiyohi County, Minnesota.

Chicago Company Brings Out New $1\frac{1}{2}$ Ton Truck

A new $1\frac{1}{2}$-ton truck has been brought out by the Available Truck Co., Chicago. The design of this truck embodies many refinements in detail. The radius rod construction is used, as it was decided that it will more effectively take the drive, leaving the spring to perfom its own particular function, and also to handle the tongue of the axle.

The engine is the Available Truck Co. design, with a multiple disc dryplate clutch, enclosed in dust-proof housing attached to motor, and four speed transmission. It has a bore and stroke of 4 in. by $5\frac{1}{8}$ in., respectively. It is capable of developing a maximum horse power of 38 at 1,080 r.p.m. The transmission is of the constant-mesh individual clutch type with four speeds forward and one reverse, and is mounted amid hip. The final drive is through a worm and gear axle with a ratio of 7.25 to 1. The drive shaft of this axle is $2\frac{3}{4}$ in. in diameter and is made of chrome nickle steel. Power is transmitted from the engine to the rear axle by two separate tubular propeller shafts provided with four universal joints. Two in front and two in rear. The frame is of rolled channel steel of Available make. It is reinforced by six cross members and strengthened by heavy gusset plates. All castings and brackets are either cast or forged steel, and are hot riveted to frame. Heat treated alloy steel springs are used. The steering gear, which is mounted on the left side, is an irreversible worm and nut type with a 20-in. steering wheel. The wooden wheels are equipped with 36 in. by $3\frac{1}{2}$ in. front and 36 in. by 5-in. rear tires.

Incinerator By-Product Paving Block.—Paving blocks are being made from the by-products of the city refuse incinerator of Berlin, according to a press dispatch, which further states that "as Germany no longer can afford to import paving materials, which Sweden used to supply, the discovery of this cheap by-product is greatly welcomed.

Bituminous Surface Treated Macadam and Gravel Roads of Dallas County, Texas

Macadam and gravel roads surface treated with bituminous material have given good service in Dallas County, Texas, under moderately heavy traffic. The manner in which these roads are constructed is described by Mr. J. F. Witt, in a recent issue of Public Roads. The notes following are taken from Mr. Witt's article.

Macadam Construction.—The macadam should be constructed according to modern specifications of sufficient depth to prevent "breaking down" of the mechanical bond under the heaviest loads contemplated. An essential factor of this requirement is a good grade of crushed stone. There is a certain but indeterminate "thrust" at the edges of the macadam surface under loading; and as the ordinary macadam has only earth shoulders to protect its edges, a weakening of the entire structure is often the result of traffic. The use of any good type of curb is usually considered to be prohibitive in cost; but a good substitute can be constructed at moderate cost by treating the outer 12 in. on each side of the macadam with bitumen applied by the "penetration method," using 1 gal. per square yard on the base course and 1 gal. per square yard on the surface course of stone. This can be done at a cost of approximately 10 ct. per linear foot of road, or approximately $530 per mile. The benefits are fully worth the investment.

When the macadam surface is finished and screenings and dust have been used to fill the voids of the body of the macadam and to fill the interstices and bond the surface, a "glazed" surface usually results after the finished rolling and especially after the road has been thrown open to traffic for a few days. Some engineers specify that the bitumen shall not be applied until such time as the traffic has prepared the surface by wearing the glaze away. Mr. Witt has tried this method and found that the traffic does not wear the surface uniformly. If the treatment is applied when that part of the road used by traffic is ready, the outer edges of the macadam will still retain the glaze, while if it is delayed until the entire surface is freed from the glaze, the center, or most heavily traveled section, will have begun to ravel, thus weakening the structure.

Preparing for the Bitumen.—It is better to keep the traffic off the roadway until after the bitumen has been applied. Before the application of the bitumen the glaze should be removed by sweeping with either wire or fiber, mechanical or hand, brooms. The job can not be properly done, however, without the use of hand brooms. A combination of the two works economically and well. But whatever method is employed the sweeping should be done with care, so that the loose flaky material and foreign matter may be removed without loosening the mechanical bond of the surface stones.

After sweeping, the surface should be flushed with water, using a pressure-flushing tank. Whether the stone surface should be damp or dry when the bitumen is applied is open to question. Mr. Witt prefers a dry surface, although in making some tests during 1917 he found the adhesion of the surface mat to damp surfaces to be as good as to those which were dry; even to wet surfaces the adhesion was very good. In the tests 12-in. square concrete blocks were used. Twelve sets of specimens were prepared, each set being made of three specimens, one wet, one damp, and one with a dry surface.

The Bitumen and Its Application.—After the surface has dried sufficiently the bitumen should be spread in two applications by a pressure distributor and the mineral covering should be spread to a depth of approximately ½ in., not earlier than 2 minutes, nor, if practicable, not later than 20 minutes, after the heavier bitumen is applied. There is no rolling after the bitumen is applied. The surface is completed with the application of the mineral covering and is left to the traffic to iron out.

Bitumen should not be applied when the open-air temperature is below 60° F. and its consistency should be as follows:

If using asphalt. First treatment—Asphaltic road oil minimum of 55 per cent asphalt of 100 penetration. Viscosity (Engler) 50 c. c. at 60° C., 100-250 seconds. Second treatment—86 per cent asphaltic road oil. Viscosity (Engler) 50 c. c. at 100° C., 555-755 seconds.

If using coal-tar derivatives: First treatment—Specific gravity at 60° F., 1.14-1.18. Viscosity (Engler) 100 c. c. at 104° F., 125-225 seconds. Free carbon not less than 4 per cent nor more than 12 per cent. Second treatment—Specific gravity at 60° F., 1.20-1.26. Viscosity (Engler) 100 c. c. at 212° F., 125-200 seconds. Free carbon not less than 12 per cent nor more than 22 per cent.

First application of bitumen to be at the rate of 0.2 gal. per square yard.

Second application of bitumen to be at the rate of 0.3 gal. per square yard.

Using tar for the first treatment and asphalt for the second treatment produces splendid results.

The mineral covering should be graded from ½ in. in size down to dust. The run of the crusher may be used, except that dust passing a 30-mesh sieve should not exceed 15 per cent. The surface crown should be about 0.3 in. per foot.

Gravel with Bituminous Surface.—After the first-class gravel road has had traffic sufficient to form a hard crust, the surface should be swept or water flushed until it is practically free from loose particles or foreign matter. The bitumen should then be applied in two courses in the same manner as for water-bound macadam.

Gravel should be used for covering material, and it should be clean, sharp, and well graded from 1 in. down to sand. The sand passing a No. 30 sieve should not exceed 30 per cent. A roller should be used on this covering to make sure the larger pebbles are securely bedded; after which the road should be opened to traffic.

All breaks which develop in the surface during a period of from 3 to 5 months after the road is opened to traffic should be repaired at once by a maintenance gang, equipped with a heating kettle and pouring pots; and at the end of this period the surface should be scarified for a depth of from 1 to 1½ in.

By then disk-harrowing the scarified material, reducing it to a mealy condition, the bitumen content will be distributed uniformly throughout the depth scarified. Dress this material with the grader blader and roll it thoroughly; follow the rolling immediately with an application of ½ gal. per square yard, using the bitumen specified for "second treatment"; cover as before, with gravel, and roll, and the road is ready for traffic.

Crushed Stone Top to Gravel.—All this work subsequent to the first opening of the road to traffic may be avoided with splendid results, if a good quantity of crushed stone be used in sufficient amount to top the gravel with a "binder course" of stone to a depth of from 2 to 4 in. The greater the depth of this "binder course," the better will be the results obtained. The stone and gravel foundation should be wet and should be rolled until the stone is imbedded in the gravel surface to a depth of approximately an inch. Such a road treated with bitumen as described for water-bound macadam, will be almost as satisfactory as an all-rock road, and can be used to advantage where crushed rock is costly and gravel reasonably cheap. The crown for the gravel or gravel and rock roads should be about ⅜ in. per foot.

Results of Iowa Traffic Census.—Traffic counts made under the direction of the Iowa State Highway Commission showed that 47.7 per cent of the travel on the highways was from farm to town or town to farm; 30.4 per cent was inter-urban, 15 per cent was inter-county, and 6.9 per cent was inter-state. About 90 per cent of the tonnage was motor driven. The classification used for the four groups noted above was: Farm-Town: All traffic from farm to town or from town farm or from one farm to another, inter-urban: All traffic starting from one town and going to another town with in the same county or to a town in another county not over 25 miles distant and all traffic starting from a town, passing out into the country and returning to the town from whence it started without touching any other town or having stopped on business or pleasure at a farm. Inter-county: All traffic starting in one county and traveling to a point in another county more than 25 miles distant. Inter-state: All traffic passing from one state to a point in another state more than 25 miles distant.

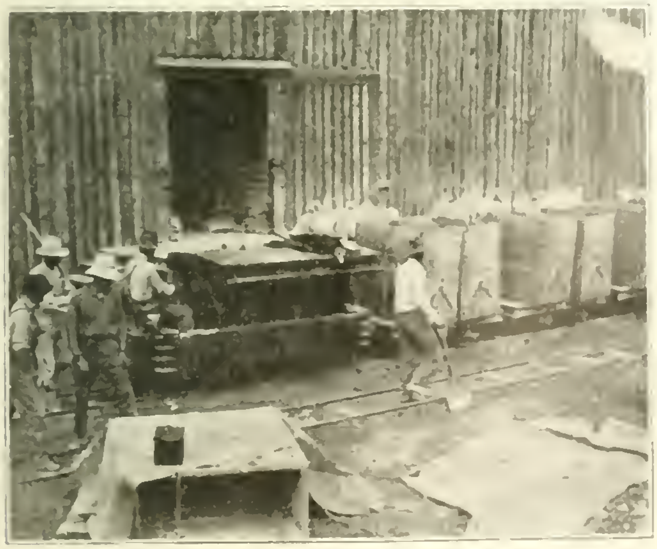
Laying 1,300 Sq. Yd. Concrete Road Pavement in 9½ Hours

Seven hundred and forty-four lineal feet of 16-ft. wide, 8-in. thick 1:2:3½ concrete pavement laid in 9½ hours with a labor force of only 32 men is a notable performance. This run was made on June 30, by Alan J. Parrish on his Federal Aid road contract near Paris, Ill.

For this job, the material yards are located at Oliver, Ill., slightly more than a mile from the road. The sand and stone are unloaded from the cars by a ½-yd. full revolving Erie crane, operating on a track parallel to the unloading siding. The crane deposits the material in material piles alongside a 24-in. industrial railway loading track. The same crane is used for filling the storage bins which make possible the speedy measuring and loading of accurate amounts of sand and stone for each batch box.

Stock Pile and Storage Bins for Sand and Stone.

The Western railway trucks, each with two batch boxes, start at the loading bins. A hump has been built in the track at the loading bins so that the train then moves by gravity to the cement loading platform, where the cement is added to each batch box. Plymouth 3-ton locomotives then haul the trains to the paver. There is no back-switching after the trains once start through the loading process; they travel continuously toward the job.


Cement Storage Shed and Loading Platform.

Each locomotive handles 10 cars, carrying 20 batches. At no time during the day when the record run was made, was there any delay in waiting for the next train to pull into position. A train was always ready on the siding. During the 9½ hours that the paver ran, 22 train loads, carrying 440 batches, were used.

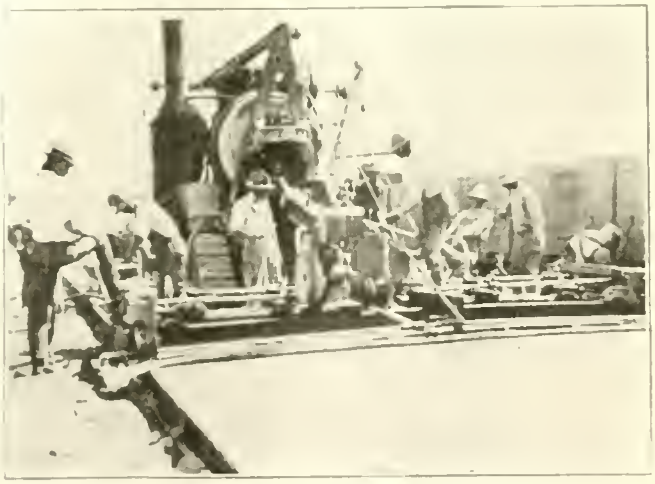
An important detail that was handled in a particularly careful manner was the method in which the contractor prepared the grade for his industrial railway system. He has found from experience that a carelessly formed grade may eventually cause expensive trouble through derailments and delays. So this grade was built up properly and thoroughly drained before any steel was placed upon it. The result has been worth while: in laying over 1½ miles of pavement so far, on this contract, he has had only two minor derailments.

The placing of the railway sidings also was carefully planned so that it would be always possible to have the train load of batch boxes at the paver just when the material was needed. This eliminated the danger of the paver having to stand idle while awaiting the aggregate.

Dumping Batch Box Into Mixer Skip.

After completing 1½ miles of the pavement, the 21-E Smith Simplex paver was moved back to the starting point and reversed, to work in the opposite direction. This reduced the length of the haul from the original loading station. The only change required was to move the mixer derrick to the other side of the machine.

The latest models of Heltzel steel forms are being used and the tamping and finishing is handled by the new Parrish tamping machine.


Parrish Finishing Machine.

A 4-bag batch is used and a full minute allowance for mixing each batch.

The entire crew when the record run was made consisted of the following:

2 crane men.
4 men loading batch boxes—stone, sand and cement.
4 train men.
8 grading crew men.
2 men ahead of paver, handling batch boxes.
1 engineer.
3 men spreading concrete behind machine.
1 fireman.
1 tamping machine operator.
2 men spading and edging.
1 superintendent.
2 foremen.
1 water boy.

Proportions for Concrete for Highway Construction

At the 23rd annual meeting of the American Society of Testing Materials, held June 22-25, the Committee on Road Materials, of which Prevost Hubbard, 25 W. 43rd St., New York City, is Secretary, submitted specifications for proportions for concrete for highway construction. The committee recommended that the specifications be published as tentative before referring them to letter ballot of the society for adoption. The proposed specifications follow.

The proportions of cement, fine and coarse aggregate for the concrete shall vary according to the sizes of the fine and coarse aggregates to be used as indicated in Table I. One sack of cement shall be considered as 1 cu. ft. and proportions shall be by volume. The quantity of cement in a cubic yard of concrete in place shall be not less than the amount as shown in the table for a given proportion of coarse and fine aggregates.

Before work is started, the contractor shall advise the engineer of the particular sizes of fine and coarse aggregates he expects to use and no change shall be made by the contractor from such sizes except upon due notice in writing to the engineer.

TABLE I.—PROPORTIONS AND QUANTITIES FOR 1 CU. YD. OF CONCRETE.*

Based upon laboratory investigations, using approved materials, compressive strength at 28 days with workable plasticity, 6 by 12 in. cylinders, 3000 lb. per sq. in.

Sizes.		Fine Aggregates, Sieve Openings per inch.														
		0 - 28			0 - 14			0 - 8			0 - 4			0 - ⅜ in.		
Coarse Aggregates	Cement in Barrels, Aggregates in Cu. Yd.	Cement.	Fine.	Coarse.	Cement.	Fine.	Coarse.	Cement	Fine.	Coarse.	Cement.	Fine.	Coarse.	Cement	Fine.	Coarse.
No. 4 sieve to ¾ in	Proportions	1	1.3	2.4	1	1.6	2.4	1	1.8	2.3	1	2.0	2.3	1	2.7	1.5
	Quantities	1.96	0.37	0.69	1.85	0.44	0.66	1.82	0.48	0.62	1.75	0.52	0.59	1.79	0.72	0.40
No. 4 sieve to 1 in	Proportions	1	1.3	2.7	1	1.6	2.6	1	1.8	2.8	1	2.0	2.6	1	2.6	1.8
	Quantities	1.90	0.38	0.76	1.77	0.42	0.68	1.72	0.46	0.66	1.67	0.50	0.62	1.72	0.66	0.46
No. 4 sieve to 1½ in	Proportions	1	1.2	3.1	1	1.8	3.2	1	1.7	3.1	1	2	3	1	2.4	2.4
	Quantities	1.82	0.32	0.84	1.58	0.40	0.79	1.63	0.41	0.75	1.61	0.47	0.72	1.62	0.57	0.57
No. 4 sieve to 2 in	Proportions	1	1.2	3.6	1	1.6	3.5	1	1.6	3.7	1	1.9	3.8	1	2.2	3.1
	Quantities	1.75	0.31	0.90	1.63	0.36	0.85	1.55	0.36	0.85	1.52	0.43	0.81	1.53	0.50	0.70
No. 4 sieve to 2½ in.	Proportions	1	1.1	3.8	1	1.4	3.9	1	1.6	4.0	1	1.8	4.0	1	2.1	3.5
	Quantities	1.72	0.29	0.97	1.58	0.33	0.91	1.51	0.35	0.89	1.49	0.40	0.88	1.50	0.46	0.78
No. 4 sieve to 3 in	Proportions	1	1.1	3.8	1	1.4	4.1	1	1.6	4.1	1	1.7	4.1	1	2.0	3.7
	Quantities	1.69	0.28	0.97	1.58	0.33	0.97	1.49	0.33	0.90	1.49	0.37	0.90	1.49	0.44	0.81
⅜ to ¾ in	Proportions	1	1.3	2.3	1	1.7	2.3	1	1.9	2.3	1	2.2	2.2	1	2.8	1.4
	Quantities	1.96	0.37	0.67	1.85	0.46	0.63	1.82	0.51	0.62	1.75	0.57	0.57	1.79	0.75	0.37
⅜ to 1 in.	Proportions	1	1.3	2.6	1	1.7	2.6	1	1.9	2.5	1	2.2	2.4	1	2.7	1.7
	Quantities	1.90	0.36	0.74	1.77	0.44	0.68	1.72	0.48	0.64	1.67	0.54	0.59	1.72	0.68	0.43
⅜ to 1½ in	Proportions	1	1.3	3.0	1	1.7	3.0	1	1.9	3.0	1	2.1	2.9	1	2.6	2.2
	Quantities	1.82	0.35	0.80	1.68	0.43	0.75	1.63	0.46	0.73	1.61	0.50	0.68	1.62	0.63	0.53
⅜ to 2 in	Proportions	1	1.3	3.3	1	1.7	3.4	1	1.8	3.5	1	2.0	3.4	1	2.4	2.9
	Quantities	1.75	0.34	0.86	1.63	0.41	0.83	1.55	0.42	0.80	1.52	0.45	0.77	1.53	0.62	0.66
⅜ to 2½ in	Proportions	1	1.3	3.7	1	1.6	3.7	1	1.7	3.8	1	2.0	3.8	1	2.3	3.3
	Quantities	1.72	0.33	0.95	1.58	0.37	0.87	1.51	0.37	0.87	1.49	0.44	0.84	1.50	0.51	0.74
⅜ to 3 in	Proportions	1	1.2	3.8	1	1.6	3.9	1	1.7	4.0	1	1.9	4.0	1	2.2	3.5
	Quantities	1.68	0.30	0.95	1.58	0.37	0.91	1.49	0.37	0.88	1.49	0.42	0.88	1.49	0.48	0.77
½ to ¾ in	Proportions	1	1.5	2.3	1	1.8	2.2	1	2.1	2.2	1	2.3	2.1	1	2.8	1.3
	Quantities	1.96	0.41	0.67	1.85	0.52	0.61	1.82	0.56	0.59	1.75	0.59	0.54	1.79	0.75	0.34
½ to 1 in	Proportions	1	1.5	2.5	1	1.9	2.5	1	2.1	2.4	1	2.3	2.4	1	2.8	1.6
	Quantities	1.90	0.42	0.70	1.77	0.50	0.66	1.72	0.53	0.61	1.67	0.57	0.59	1.72	0.72	0.41
½ to 1½ in	Proportions	1	1.4	2.8	1	1.8	2.9	1	2.1	2.9	1	2.2	2.8	1	2.7	2.1
	Quantities	1.82	0.37	0.75	1.68	0.47	0.73	1.63	0.51	0.69	1.61	0.52	0.66	1.62	0.65	0.51
½ to 2 in	Proportions	1	1.4	3.3	1	1.8	3.3	1	2.0	3.4	1	2.2	3.3	1	2.7	2.7
	Quantities	1.75	0.36	0.86	1.63	0.46	0.79	1.55	0.48	0.78	1.52	0.50	0.74	1.53	0.62	0.62
½ to 2½ in	Proportions	1	1.4	3.8	1	1.8	3.6	1	1.8	3.7	1	2.1	3.7	1	2.6	3.1
	Quantities	1.72	0.35	0.91	1.58	0.43	0.85	1.51	0.42	0.83	1.49	0.46	0.81	1.50	0.57	0.69
½ to 3 in	Proportions	1	1.3	3.7	1	1.8	3.8	1	1.8	3.8	1	2.1	4.0	1	2.4	3.3
	Quantities	1.68	0.33	0.92	1.58	0.42	0.89	1.49	0.40	0.86	1.49	0.48	0.88	1.49	0.53	0.63
¾ to 1 in	Proportions	1	1.7	2.4	1	2.1	2.4	1	2.4	2.1	1	2.8	2.2	1	3.1	1.5
	Quantities	1.90	0.48	0.68	1.77	0.55	0.64	1.72	0.61	0.53	1.67	0.64	0.55	1.72	0.79	0.39
¾ to 1½ in	Proportions	1	1.7	2.7	1	2.0	2.8	1	2.3	2.7	1	2.5	2.7	1	3.0	2.0
	Quantities	1.82	0.46	0.73	1.79	0.50	0.70	1.63	0.55	0.65	1.61	0.58	0.64	1.62	0.73	0.48
¾ to 2 in	Proportions	1	1.7	3.1	1	2.0	3.1	1	2.3	3.1	1	2.5	3.0	1	3.0	2.4
	Quantities	1.75	0.44	0.80	1.63	0.48	0.75	1.55	0.53	0.72	1.52	0.56	0.67	1.53	0.69	0.55
¾ to 2½ in	Proportions	1	1.7	3.3	1	2.0	3.5	1	2.3	3.4	1	2.4	3.4	1	2.8	2.6
	Quantities	1.72	0.43	0.84	1.63	0.47	0.83	1.51	0.52	0.76	1.49	0.53	0.75	1.50	0.64	0.62
¾ to 3 in	Proportions	1	1.7	3.5	1	2.0	3.7	1	2.3	3.7	1	2.4	3.6	1	2.8	3.1
	Quantities	1.68	0.43	0.89	1.58	0.47	0.87	1.49	0.51	0.81	1.49	0.53	0.79	1.49	0.62	0.68
1 to 1½ in	Proportions	1	1.7	2.8	1	2.0	2.9	1	2.3	2.7	1	2.6	2.6	1	3.1	2.0
	Quantities	1.82	0.46	0.75	1.68	0.50	0.73	1.63	0.55	0.65	1.61	0.62	0.62	1.62	0.75	0.48
1 to 2 in	Proportions	1	1.5	3.2	1	1.9	3.5	1	2.2	3.3	1	2.4	3.3	1	3.0	2.6
	Quantities	1.75	0.39	0.83	1.63	0.46	0.85	1.58	0.51	0.76	1.52	0.54	0.74	1.53	0.68	0.59
1 to 2½ in	Proportions	1	1.4	3.4	1	1.9	3.8	1	2.0	3.7	1	2.3	3.7	1	2.7	3.1
	Quantities	1.72	0.35	0.88	1.58	0.45	0.90	1.51	0.44	0.8[illegible]	1.49	0.51	0.81	1.50	0.59	0.69
1 to 3 in	Proportions	1	1.3	3.6	1	1.8	4.0	1	2.0	3.9	1	2.2	3.9	1	2.7	3.3
	Quantities	1.67	0.33	0.90	1.58	0.42	0.91	1.49	0.44	0.8[illegible]	1.49	0.48	0.86	1.49	0.59	0.73

*Table devised by D. A. Abrams, Lewis Institute, Chicago.

To determine in what classification a given aggregate shall fall the following method shall prevail:

For fine aggregate, there shall be not less than 15 per cent of the total volume between the coarsest size and the next smaller size shown in the table. Thus, if fine aggregate is to be classed as ¼-in. size, there shall be not less than 15 per cent of the material between the No. 4 sieve and the No. 8 sieve. A fine aggregate to be classed as 0 to 28 shall have not less than 15 per cent retained on a No. 48 sieve, and no fine aggregate shall be used that has more than 10 per cent passing a No. 100 sieve.

For coarse aggregate, there shall be not less than 10 per cent of material between the largest size and the next smaller size shown in the table. Thus, a coarse aggregate to be classed as 2½-in. size shall have not less than 10 per cent of the material between the 2½-in. size and the 2-in. size.

In each instance, whether fine or coarse aggregate, if there are not of the coarser sizes the amounts as here described, the upper limit of size of the material shall be that of the next smaller size. That is, an aggregate that contains some 2½-in. material, but less than 10 per cent between 2½ in., and 2 in. shall be classed as 2-in. size for the upper limit.

The lower limit of size of a coarse aggregate shall be the size shown in the table for coarse aggregate below which there is not more than 10 per cent by volume of the material.

If more than 5 per cent of the volume of coarse aggregate passes the No. 4 sieve, then such excess shall be considered as fine aggregate and the amount of fine aggregate to be used shall be modified accordingly.

Aggregate falling between limits of sizes other than shown by the table may be used only upon special written permission of the engineer and in such proportions as he may indicate.

In all cases, aggregates both fine and coarse are presumed to be reasonably well graded between the limits specified.

The sieves and sizes referred to herein and in Table I, are according to what is known commercially as the Tyler Standard Screen Scale.

A Plan for Removing Risks from Contract Work in County Road Construction

As a means for removing some of the risks that confront road contractors, Mr. J. M. Isbell, County Engineer of Wichita County, Texas, in a paper presented at the recent annual meeting of the Texas Road Builders' Association, suggested that counties bid in their own work and sub-let it to contractors on a co-operative contract basis, with a fixed fee and penalty and bonus clause included. Under this plan the county would obtain its own materials, and assume all hazards of rising labor or material prices. This form of contract, according to Mr. Isbell's paper, would insure to the county the following advantages:

First: Eliminates the various hazards that make highway work unattractive to the better class of contractors, and thus aids in securing first class and properly equipped men to handle the work at a reasonable bid, after the gamble has been removed. The contractor receiving a fair profit, which is justly due him.

Second: Gives the county the advantage of any decline in prices of material and labor, which would appear to have reached its peak at the present time.

Third: Reduces engineering expense, by eliminating part of the inspection, this being co-operative work.

Fourth: Eliminates any disputes with contractor as to kind or quantities of material used, thereby insuring first class construction.

Fifth: Eliminates the cost of surety bond and many other items which must be included in prices bid in regular contract.

Further abstracts from the paper follow:

A county may bid in its work and do the actual detail construction with its own forces, by purchase of necessary equipment. This plan would only be practicable in the construction of sand-clay or gravel roads as no extremely heavy expense would be involved in the purchase of equipment and supplies. In this case it would only be necessary to purchase simple equipment and this supplemented by the equipment available from the Federal Government through the state highway department, such as trucks, tractors, graders, mixers, etc., would make the expense for equipment to handle negligible. Such equipment would be available for maintenance after construction work is completed. This would place at the disposal of the maintenance organization desirable equipment, that is seldom obtainable.

An engineer or competent foreman could be placed in charge of actual construction and the cost of construction very materially reduced over contract work.

This plan of handling gives at all times [illegible] index of the cost of the work.

There is one serious disadvantage in the handling of county detail construction work by the county organization, that is unraveling the "Red Tape" connected with the expenditure of county funds.

In the construction of a great system of permanent highway this plan would not be practicable as the expenditure for equipment and mechanical devices would be too great for the amount of work to be done. This class of equipment would be of no practical value on maintenance and would have to be sacrificed. It is also impossible, for obvious reasons, for counties to secure a sufficiently efficient organization to handle such a permanent highway system.

Opportunities in Highway Transportation Field*

By R. D. CHAPIN,

President Hudson Motor Car Co.

Last year 1,[illegible]00,000,000 tons of freight were hauled by the motor trucks of the country as against 90,000,000 tons carried on the Great Lakes and the Mississippi and 2,504,000,000 hauled by the railroads. In all of this great new transportation development there appears a pressing need for highway transportation engineers, men skilled in production and operation of these transportation units. It is necessary that we should have these men by the thousands if we are to avoid waste in this great new development and to secure the maximum benefit which we should receive.

In order to handle this subject intelligently, it is necessary that it should be co-ordinated with other forms of transportation, since only through co-ordination can we hope to obtain the greatest efficiency in the use of each unit. We know that the motor truck is not capable today of competing with the railroad in the long haul. We know that under certain limitations it can serve to relieve the railroads. We should have men trained in the analysis of these problems, able to tell us what the definite economic limitations are. With the increasing use of highway transportation our traffic problems are becoming acute. In the larger cities as well as in the smaller we see a growing need for definite well-laid-out plans for the operation of motor vehicles.

Mutual Problems of User and Builder of Highways. There is a further need for close cooperation between the men who are using the highways and the men who are building them. Their problems in many subjects are mutual. The highway transportation engineer brings to the knowledge of the highway engineer a vision as to the future use of highways. He knows something of the trend of production and of the character and types of vehicles which travel over the roads of the future.

His knowledge should be of definite value to the highway engineer, since in the last analysis road expenditure can only be justified by the volume of the traffic which goes over the completed highways. It is not enough to say that we will build a road. We should know what the future traffic will be once that road is completed and on our vision of the future we should determine the type of highway which is to be built. In other words, I should say that road building is now an economic problem first of all. Location of the highway should be [illegible] [illegible] to the tonnage which may be developed along [illegible] and to the character of passenger travel which [illegible] the highway.

Need for Further Knowledge in Road Building. There is an imperative need for the widest kind of research work. I doubt if there is any man in the United States, skilled though he may be, who can define what character of road should be constructed to withstand the traffic 10 years from now. The tremendous growth of motor transportation has outstripped our scientific knowledge just as it has outstripped our legal procedure, even administration procedure in our automobile factories in some instances.

It is time now that we checked up on the work which we are doing. We should not proceed to spend these hundreds of millions of dollars without knowing in what direction we are going or what results we are to obtain. The colleges and schools should heed this well, as it is the people's money which builds the roads and it is the people who support the schools and colleges and who are vitally interested in both of these subjects. These problems can be solved and our colleges should aid their solution by the institution of broad courses in highway engineering, increased facilities for research and a broadcast movement to acquaint the public with the high importance of skilled men in this task.

Lack of Trained Men in Highway Transportation Field. The enormous development in motor transportation has brought about a need for trained men in all of the phases of highway transportation, from the department of research and design down to the operator on the road. Glancing over the field it will be found that trained men are lacking. We have simply not had the time as yet to develop them and we must rely upon our colleges to undertake this task.

It is true in the automobile industry, as it is in other industries, that whenever a man is able to perform his duties well salary becomes a secondary matter from the standpoint of the manufacturer. There is an unlimited field for the ambitious man, properly trained, who enters the automobile industry.

The subject is a popular one. It takes to itself all the [illegible] and romance which in another day and another [illegible] led the student to take up the subject of railroad transportation. The boy who goes into the field of highway transportation, whether he goes in as engaged in the production and use of the vehicle or as one engaged in the construction of the road, becomes an intimate part of the life not only of his community but of his state and of the nation. He is doing more than earning a mere living. He is making it possible for others to obtain more from life. For upon the adequacy of our transportation facilities rests, in large measure, the breadth of life of all of us.

The subject is one which is bound to increase in importance. There are 8,000,000 automobiles in use in the United States today. Each year sees the number increasing by [illegible] millions. Except in Europe, the use of the motor vehicle has been largely restricted in other countries. Lack of appreciation, lack of funds, lack of highways have been responsible. Today we see a changed condition abroad. More and more automobiles are being demanded from this country. Last year our export showed an increase of 79 per cent. In the years to come we may expect to see broad highways driven into the heart of old Europe, Asia and Africa, opening potential resources almost beyond the vision of any of us present. All this means that there will be an ever increasing field of usefulness, both in the engineering and highway transportation fields.

The Opportunities of the Colleges. When we go to the colleges there should be definite outlines which will equip men for the highest type of employment in these fields. In some cases these courses will be found in the engineering schools, but there will always be a need for a number of men trained in business administration, salesmanship and advertising who should have more than a vague understanding of the specialized automobile field.

Special degrees should be given in these subjects by our colleges. The reason is not hard to find. Highway engineering is as important a branch of engineering as is any other specialized form, such as railway engineering. Highway transportation will require more men than railroading.

The task ahead is a large one. It is one of sufficient importance to engage the attention of leaders in the two fields in the United States.

---

*Abstract of a paper presented May 14 at the conference on vocational instruction in highway transportation and engineering held under the auspices of the U. S. Bureau of Education.

The So-Called Asphalt Content of Road Oils*

By B. A. ANDERTON and D. G. TAYLOR.

The grading of asphaltic road oils on the basis of the percentage of asphalt contained in them is still in extensive use as a means of differentiating between various types of oils —that is as between their inherent nature and consistency. Notwithstanding that there are obvious difficulties in making the test, and that its value has been for some time severely criticized, a conference of state highway testing engineers and chemists, held in Washington in 1917, deemed the test of such extensive use as to warrant including it as an alternate requirement in forms of specifications drawn up for road oils. The method of making the test was also considered, and in the report[1] of the conference the recommended procedure to be followed is given, as follows:

PERCENTAGE OF RESIDUE OF——PENETRATION.

Fifty grams of oil are placed in a 3-oz., deep, seamless tin box; the box is placed in a sand bath and heated over a Bunsen burner. A thermometer is suspended in the oil, the bulb not touching the bottom of the box. The temperature of the oil is kept at from 249 to 260° C. (480 to 500° F.), and the oil is stirred from time to time with the thermometer to prevent overheating in any part. Depending upon the nature of the oil, as usually indicated by its flash, consistency at 25° C. (77° F.), and the specific gravity, the operator can with experience tell about what percentage it will be necessary to evaporate before cooling and taking a penetration of the residue. It is sometimes necessary to make several trials before the desired result is obtained. When the required penetration is reached, the residue left from evaporation is weighed and its percentage of the original sample taken is computed.

The Bureau of Public Roads, with a desire to investigate how closely the various characteristics of a sample would indicate the percentage of residue of 100 penetration, as suggested in this description of the test, has made a large number of determinations following the procedure given as closely as possible. From the results of this work, we will attempt in this communication to present the most significant indications as to the value of the test for asphalt content. We may divide the selected tests into three groups as follows:

1. Residual petroleums, asphaltic petroleums, and oil asphalt cut-backs having different specific gravities and consistencies;

2. A series of Mexican products having specific gravities ranging from 0.935 to 1.021 and specific viscosities at 100° C. ranging from 2.4 to 131.0 and a series of Mexican products having specific gravities ranging from 0.935 to 0.965, with specific viscosities at 25° C. ranging from 20.4 to 165.0, and with flash points ranging from 42 to 105;

3. A selected sample upon which numerous tests were made to discover effects, if any, that varying conditions might have upon the results.

In all the tests with the exception of those under No. 1, it was desired to obtain a residue that would yield a penetration of 100.

Group No. 1 Tests. In the tests of group No. 1, it was found that no general relation could be discovered between the percentage of asphalt and ordinary test characteristics of the sample. The source of the oil has a great influence on the results of the test; for instance, two oils from different sources when heated for the same length of time will give entirely different amounts of residue, notwithstanding the fact that they have practically the same consistency or specific gravity; and when these samples have been heated until the residues show the same penetration they do not necessarily have the same percentage of residue. This was shown when tests of Mexican oils were compared with tests of other oils. Some typical results are given in Table I.

A comparison of the Mexican product with the Texas product shows that when the samples had been heated until they gave the penetration, the difference in the percentage of their residues was 9.6. A comparison of the Mexican product with the Trinidad product shows that when the samples had been heated until they gave the same penetration, the difference in the percentage of their residues was 5.2. With the Mid-Continent residual it is shown that a much lower percentage of asphalt results, although the original oil was slightly heavier, and the residue somewhat softer. In the last case, a comparison of the Mexican product with the California product shows that there was only a slight difference in the percentage of their residues. It may be especially noted that the evaporation took place much more rapidly with the Mexican samples, and it necessarily required a shorter time to gain residues, yielding a penetration of approximately 100 with such oils.

Group No. 2. Tests. The results of tests made on materials stated under Group No. 2 are given in Table II. Generally speaking, it was found that an approximate relation exists between the percentage of residue of 100 penetration and between the consistency, the specific gravity, the flash point, and the percentage insoluble in 86° B. naphtha. Of these relations the one involving the consistency of the material is probably the best aid in estimating the asphalt content of an oil. From the plot between the percentage of asphalt and the specific viscosity shown in Fig. 1, however, it will be noted that an estimate of the percentage of asphalt of 100 penetration can be made only within rather wide limits.

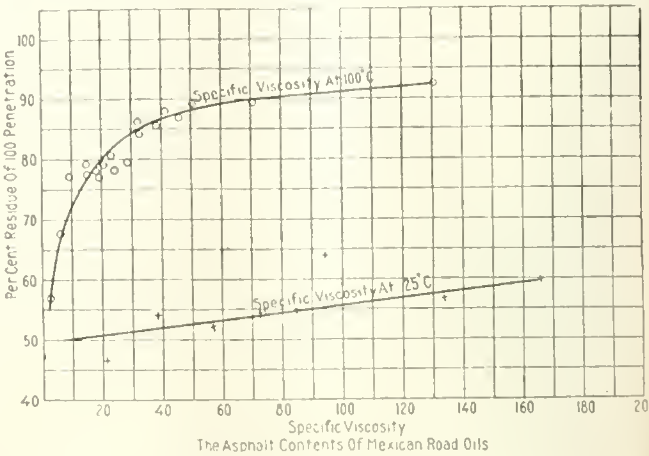


Fig. 1.—The Asphalt Content of Mexican Road Oils.

Thus, judging from this graph, the percentage necessary to be volatilized from a sample having a specific viscosity at 100° C. ranging up to 60 may be inferred within not less than three per cent.

Group No. 3 Tests. In group No. 3, the material selected was a Mexican asphalt having an original penetration of 177. First, six samples were taken and tested in the regular way. The first sample was heated for five minutes at the required temperature (249 to 260° C.) and each successive sample was heated five minutes longer than the preceding one. Samples Nos. 2 and 3 were reheated at the required temperature. Then two additional samples, Nos. 7 and 8, were heated for twenty minutes at the required temperature, No. 7 being stirred very frequently and No. 8 continuously. Penetration tests were made on the residues from the above samples with the results shown in Table III. It will be noted that the loss is not proportional to the time of heating. If the test made on sample No. 4 is compared with that made on sample No. 2, it will be seen that a residue of 96.0 per cent gave a penetration of 100 and that when sample No. 2 was reheated for five minutes at the required temperature a residue of 96.0 per cent was obtained, also yielding a penetration of 100. Again, if the tests made on samples Nos. 3, 5, and 7 are compared it will be seen that

TABLE I.—COMPARISON OF TESTS MADE ON MEXICAN OILS WITH TESTS MADE ON OILS FROM OTHER SOURCES.

Type of Oil.	Specific Gravity.	Specific Viscosity. At 25° C.	At 100° C.	Time Heated at 249 to 260° C., min.	Percentage of Residue.	Penetration of Residue.
Mexican	0.965	165.0	....	45	59.5	100
Texas	0.910	163.6	....	95	69.1	100
Mexican	0.943	94.8	....	35	64.2	97
Mid-Continent	1.031	99.0	....	50	54.4	102
Mexican	1.001	....	24.1	45	78.4	103
Trinidad	1.001	...	29.1	90	83.6	103
Mexican	0.991	....	16.8	30	78.0	97
California	0.991	....	17.0	120	76.4	100

---

[1] "Standard Forms for Specifications, Tests, Reports and Methods of Sampling for Road Materials, "Bulletin No. 555, U. S. Department of Agriculture, Washington, D. C., November 25, 1917.

*A paper presented at the 23rd annual meeting of the American Society for Testing Materials at Asbury Park, N. J., June 22-25.

TABLE II.—PERCENTAGE OF RESIDUE OF MEXICAN OILS

Serial No.	Specific Gravity.	Specific Viscosity.	Percentage [illegible]	Flash Point [illegible]	Percentage of Residue.	Penetration of Residue.
		SPECIFIC VISCOSITY AT 100° C				
14104	[illegible]	2.4	[illegible]	[illegible]	[illegible]	100
14041	[illegible].961	6.2	[illegible]	[illegible]	[illegible]	78
12927	[illegible].995	12.8	[illegible]	[illegible]	[illegible]	[illegible]
10160	0.[illegible]	9.1	1[illegible]	[illegible]	[illegible]	91
10491	0.991	16.8	1[illegible]	60	[illegible]	9[illegible]
11147	0.995	17.[illegible]	[illegible]		78.[illegible]	[illegible]
1037[illegible]	[illegible].996	18.6	[illegible]		[illegible]	[illegible]
11164	1.0[illegible]4	24.4	[illegible]		[illegible]	1[illegible]
1047[illegible]	0.99[illegible]	15.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11151	1.005	2[illegible].6	[illegible]		[illegible]	98
1163[illegible]	1.001	29.1	[illegible]		[illegible]	10[illegible]
1109[illegible]	1.002	22.5			[illegible]	10[illegible]
10500	1.013	32.[illegible]			[illegible]	10[illegible]
14106	0.991	38.[illegible]	20		[illegible]	10[illegible]
14045	1.004	32	[illegible]		[illegible]	1[illegible]
14126	0.998	46.0		[illegible]	[illegible]	92
12326	[illegible].9[illegible]	41.6	20.[illegible]		[illegible]	1[illegible]
123[illegible]	1.008	51.7	[illegible]		[illegible]	[illegible]
10266	1.015	70.0	21		[illegible]	[illegible]
12413	1.024	131.0	22.8		[illegible]	[illegible]
		SPECIFIC VISCOSITY AT [illegible]				
10656	0.[illegible]6	20.4	[illegible]	[illegible]	[illegible]	[illegible]
14042	0.951	57.0	13.3	100	[illegible]	80
12026	0.943	78.6	13.1	45	[illegible]	[illegible]
1104[illegible]	0.938	72.9	13.[illegible]	100	[illegible]	8[illegible]
1239[illegible]	0.926	85.0	13.4	10[illegible]	[illegible]	[illegible]
11104	[illegible].925	133.8	13.8	70	[illegible]	[illegible]
11810	[illegible].965	165.0	16.0	65	[illegible]	[illegible]
11766	[illegible].943	91.8	11.[illegible]	42	[illegible]	[illegible]

[1] Interpolated from results of two tests—one having [illegible] higher residue and the other a slightly lower residue.

TABLE III—TESTS MADE TO NOTE RESULTS FROM HEATING DIFFERENT LENGTHS OF TIME

Mexican Asphalt Sample No.	Time, Heated at 249 to 260° C. min	Percentage of Residue.	Penetration of Residue.
1	5	99.6	150
3	15	97.6	13[illegible]
[illegible]	10	97.2	12[illegible]
[illegible]	25	96.4	105
4	20	96.0	100
[illegible]	[illegible]0	95.2	96
	EFFECT OF REHEATING SAMPLES NOS. 2 AND 3		
[illegible]	10	97.2	129
	5 additional	96.0	10[illegible]
	5 additional	95.0	[illegible]
[illegible]	15	97.6	1[illegible]
	5 additional	96.4	102
	EFFECT OF STIRRING.		
[illegible]	[illegible]0	97.6	120
	5 additional	96.4	104
[illegible][b]	20	97.0	111

[a] Stirred very frequently.
[b] Stirred continuously.

their final residues are the same (96.4 per cent) although sample No. 3 was reheated and sample No. 7 was both reheated and subjected to excessive stirring. The penetration tests on these residues showed a maximum difference of only three points. This would seem to indicate that intermittent heating or increased stirring did not affect the results to any great extent, although it must be conceded that results with such a viscous material, and having such low losses, are not conclusive as applied to fluid road oils.

Conclusions.—As a result of the work carried out as above described, certain conclusions are suggested to us:

1. That with a given type of oil, the consistency will indicate the percentage of asphalt;

2. That the time necessary to secure the required residue will vary within wide limits, and cannot be readily estimated while making the test as described;

3. That the effect of stirring is indicated to be less than that of other factors difficult to control, which affect the results.

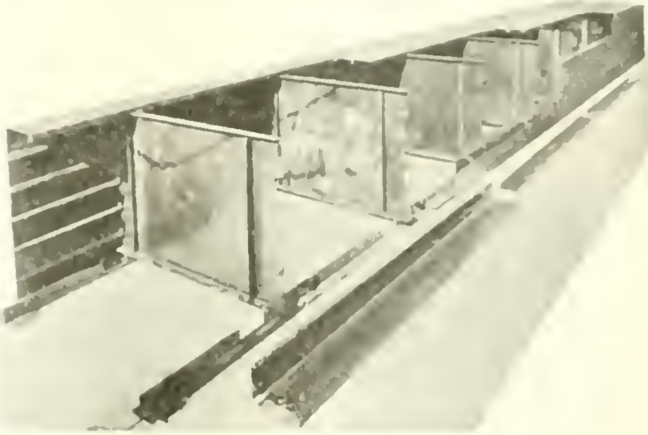
There are many features of the test which may be adversely criticized. Among these may be enumerated the following: The tedious and long continued attention necessary to secure even approximate results, the difficulty in maintaining the required temperature, which is of great importance to secure concordant results; the fact that the changes taking place during heating are not understood and probably not indicative of the changes in the oil while in service on the road. At best it is a "cut and try" method, and therefore cannot be based on scientific principles of testing.

Summarizing our conclusions, it may be stated that it is our belief that the percentage of asphalt [illegible] additional information on the suitability of a road oil for a given purpose, which is not adequately shown by the results of other tests, better understood and at the present time well standardized.

A New Flat-Top Culvert Form

A flat top collapsible, adjustable, one man culvert form, designed by H. E. Bilger, formerly road engineer of the Illinois State Highway Department, has been placed on the market recently. The forms consist essentially of only three parts, namely, base angles, centers and cover plates.

The base angles are 9 ft. long, made of steel [illegible]16 in. thick and are all alike, symmetrical and interchangeable throughout all the sizes the forms build. Instead of notching the vertical leg of a large angle as shown in the picture, a smaller angle is now used and has riveted onto it ¼-in. beveled plates that constitute the elevated bases upon which the centers set. These bevels are in pairs, 30 in. apart in the clear instead of 6 in. as shown in the picture, and this intermediate lower space serves as a pit into which the center drops when the angle is driven 4 in. by striking it at the end with a maul or axe. A short angle is riveted on each side of the base angle at each end. One of these angles prevents the base angle from tilting over, and the other prevents the bottom flange of the lowest cover plate from being crowded under the horizontal leg of the base angle by the green concrete in the side wall.



Several 9-ft. Lengths of 36 by 48-In. Bilger.

The centers are made of 14 gauge (5/64 in. thick) steel plates, stiffened against buckling by horizontal flanges at top and bottom, and also by heavy angles riveted vertically onto the main plate. At 6-in. intervals along each vertical edge of the center there are riveted hooks that fit through the holes in the flanges of the cover plates. The length of these hooks bears such relation to the height of the ¼-in. beveled plates on the base angle, that when the center drops off the bevel down onto the angle, the hooks are out of the holes and the cover plates are released. The hooks are made of ½-in. rounds. On the lower surface of the bottom flange of the center there are small angles that automatically space the base angles the proper distance apart for the particular center being used. No measuring whatever is needed to set up the forms of any size.

All cover plates are 9 ft. long and are made of 14 gauge hot-rolled blue annealed steel. The corner plates are 6 in. vertically by 9 in. horizontally, all one piece. Along each edge they are flanged 1½ in. for stiffness, and these flanges are symmetrically punched to receive the hooks on the centers. All corner cover plates are interchangeable. The side and top cover plates are 6 in. wide after being flanged 1½ in. along each edge for stiffness. The edge of each flange is then turned over again and bent completely back upon itself, forming a bead that further stiffens the plate and in addition makes it easy to handle as all sharp edges are removed. These flanges are symmetrically punched to receive the hooks on the centers. All sides and top cover plates are alike, symmetrical and interchangeable.

The method of collapsing the forms is as follows: At either end of the forms strike the ends of the base angles with a maul or even a hand-axe, driving them longitudinally 4 in. on the concrete base bringing the beveled plates out from under the centers. All base angles that are butted end to end go along together, but the centers remain fixed against horizontal movement because of the hooks being through the holes of the plates, and the plates resting upon the concrete base. The centers may or may not drop of their own weight off the beveled plates onto the base angles. If they do, the hooks are entirely out of the holes of the flanges and all cover plates are released and can be drawn out before the centers are taken out if desired. If the centers do not drop of their own weight, use a bar 1 or 2 ft. long in the 1½-in. vertical space between the top of the center and the top plates dropping the center onto the base angles. Then the center while still upright can be swung around off the base angles, by reason of the 30-in. space between the bevels, and taken out. Do likewise with the second center of the same [illegible] ft. length of form, and then all the cover plates can easily be taken out. Lastly, the base angles are removed, and the form is ready for re-use. This culvert form is manufactured by the Highway Culvert Form Co., Box 36, Peoria, Ill.

W. G. Thompson, Former State Highway Engineer of New Jersey Joins Lakewood

Mr. W. G. Thompson, whose resignation as state highway engineer of New Jersey was noted in these columns a few days ago, has become associated with the Lakewood Engineering Co., with headquarters at 141 Center St., New York City.

Mr. Thompson's first engineering experience was with Charles A. Nichols, a civil engineer of New Haven, Conn., on general surveys and engineering work covering water works, and street railway location and construction.

W. G. Thompson.

In 1904 Mr. Thompson was with the United States Engineering Department as inspector of dredging and breakwater work on Long Island Sound. From February, 1905, until March, 1910, he was a member of the Engineering Department of the Panama Canal, engaged in general survey and construction work, including topographical and railroad surveys, railroad and shop building construction. From May, 1910, until June, 1911, Mr. Thompson was employed as a draftsman in the chief engineer's office of the Oregon & Washington R. R. in Seattle, engaged principally on passenger terminal and freight classification yard layout. From June, 1911, to June, 1916, he was employed as supervisor and superintendent of construction on the locks and terminal facilities of the Panama Canal. His work included the construction of reinforced concrete wharves, foundations, and of shop buildings as well as the general construction of terminal facilities. During this time Mr. Thompson was in full charge of the construction of the Cristobal coaling plant, at the Atlantic entrance to the Panama Canal.

From November, 1916, until April, 1917, he was employed by the Raymond Concrete Pile Co. of New York as superintendent on the construction of the Sun shipyard at Chester, Pa., and later as superintendent of construction for the Raymond Co. at the Bethlehem Steel Plant at Steelton, Pa. In April, 1917, he was appointed assistant state highway engineer of New Jersey upon recommendation of General George W. Goethals, then consulting engineer to the state. In April, 1918, Mr. Thompson was appointed state highway engineer, having full charge of the State Highway Department and its work.

Prices of Culvert Pipe in Nebraska. Up to July 1 the Nebraska State Highway Department had contracted for 17,294 lin. ft. of concrete pipe culverts and 18,666 lin. ft. of corrugated pipe culverts. The average (1920) price for these pipes, according to the July monthly report of the Nebraska Department of Public Works, has been as follows:

18 in. concrete	38,600 lin. ft.	$ 3.09
24 in. concrete	10,150 lin. ft.	4.07
30 in. concrete	2,208 lin. ft.	5.34
36 in. concrete	2,182 lin. ft.	6.96
48 in. concrete	836 lin. ft.	11.81
60 in. concrete	88 lin. ft.	12.50
18 in. corrugated	12,949 lin. ft.	2.51
24 in. corrugated	3,631 lin. ft.	3.92
30 in. corrugated	1,310 lin. ft.	5.22
36 in. corrugated	154 lin. ft.	6.51
48 in. corrugated	260 lin. ft.	10.08

Road Work in Texas. Early in July there was under construction under the supervision of the State Highway Department of Texas 1,612 miles of designated highways at a total estimated cost of $22,000,000, including state and Federal Aid. Twenty Federal Aid projects whose plans, specifications and estimated cost have been approved and upon which contracts will be awarded in the near future amount to 284 miles, costing $3,100,000, involving Federal Aid to the amount of $1,400,000. There are 65 projects, both state and Federal aid, whose applications have been approved and on which plans are now being prepared for 875 miles, costing approximately $9,840,000, and on which will be paid $2,835,000 Federal Aid and $285,000 state aid.

Kentucky to Have State Road Fund of $2,750,000. According to the estimate of Joe Boggs, State Highway Engineer of Kentucky, the state road fund for 1920 will total $2,750,000. Of this sum $1,700,000 will be derived from the tax on motor horsepower, $450,000 from the 1-ct.-a-gallon gasoline tax, and $600,000 from the 3-ct. road tax. These figures show that the automobile owners of the state will pay $2,150,000 of the road fund, the remainder being derived from the ad valorem tax. The plans of the Highway Commission for next year call for the maintenance of about 300 miles of the state highway system designated by the last session of the General Assembly, at a cost of $1,000 a mile.

Industrial Notes

The Austin Machinery Corporation, a consolidation of the F. C. Austin Machinery Co., Inc., the Linderman Steel & Machine Co., the F. C. Austin Drainage Excavator Co., and Municipal Engineering & Contracting Co. has recently added the Toledo Bridge & Crane Co. to the consolidation. It also is quite likely that other large companies will be taken in in the near future. The directors of the Austin Machinery Corporation are: Ralph Crews, director, National City Company, New York; Clay H. Hollister, president, Old National Bank, Grand Rapids, Mich.; B. A. Linderman, president, Linderman Steel & Machine Co., Muskegon, Mich.; Samuel McRoberts, formerly vice-president, National City Bank, New York; C. A. Peckham, president, Toledo Bridge & Crane Co., Toledo, Ohio; John R. Shaw, vice-president, Canadian Manufacturers' Assn., Woodstock, Ontario. B. A. Linderman is president of the corporation. A line of industrial locomotives, cars and batch boxes has been added to the machinery for moving earth and mixing concrete manufactured by the corporation.

The Heil Co., manufacturers of tanks, truck bodies and hoists, Milwaukee, Wis., has under construction an addition to its plant. This addition will be 136 by 250 ft., or about 35,000 sq. ft., which will make a total of 150,000 sq. ft. for the Heil plant. This new addition will be used for storing material and as a mounting department for dump bodies and hydro hoists. The store-room will be equipped with all necessary machinery for fabricating material which will be fed to the existing shops.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies
- (e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power and Pumping
- (e) Management and Office System

Railways and Excavation—3rd Wednesday
- (a) Excavation
- (b) Management and Office System
- (c) Quarries and Pits
- (d) Steam Railways, Construction and Maintenance
- (e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Harbor Structures
- (d) Miscellaneous Structures
- (e) Properties of Materials
- (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., AUGUST 11, 1920. Number 6

Direct vs. Representative Democracy

Few that have not recently reviewed the history of our federal constitution realize that its framers were strenuously opposed to direct democracy. Recent political tendencies have been toward that form of democracy. For example, the direct primary, the initiative and the referendum are all methods whereby the voters decide questions directly instead of securing decisions through representatives.

It was the intention of the framers of the constitution to have an electoral college select the President of the United States. That intention was speedily frustrated by the action of political parties in virtually pledging the delegates to the electoral college to vote for a particular presidential nominee. The party convention, an extra-constitutional organization, was devised to enable political leaders to name the presidential nominee. Revolt against this form of bossism led to the introduction of the direct primary. Many newspaper owners supported the direct primary because they believed it would give political power to them. As evidence of the soundness of that reasoning perhaps it is significant that both the presidential nominees of the leading parties this year are newspaper proprietors.

The direct primary, like every other device for securing a direct expressions of opinion from the voters, has no economic merit. Consider, for example, the effect of electing the presidents of all the railways by a vote of the people. Obviously it would rarely be the efficient railway executive who would become a railway president. On the contrary, such presidencies would go frequently to men possessed of the means of securing publicity for themselves, whether by print or by tongue.

If voters are not able to select men best fit to run a railway system, certainly they are not able to choose the best chief executive for a nation. Doubtless it was reasoning of this sort that led the founders of this republic to avoid direct democracy as far as practicable. Nevertheless, we are rapidly drifting toward that form of democracy, and we are not only drifting but are being towed toward it by many mental tug boats. Thus, the leaders of labor unions are advocating the direct election of federal judges and "recall laws" under which a judge can be voted out of office if he renders a decision that does not please the populace. There seems to be something peculiarly reprehensible in thus attempting to intimidate a judge, yet does it differ essentially from any public mandate to a public official? In its stupidity is not the recall of a judge on all fours with the recall of a mayor, or of any other official who has displeased a majority of the voters?

Bearing in mind that even the best trained official with all the available facts before him may frequently err, what are the chances that a totally untrained populace with relatively few facts before them will be right?

Civil engineers know that the public repeatedly ignores their advice, or acts contrary to it, when they have pointed out the most economic step to take. Either because of mass inertia or because of ignorance, the public, time and again, neglects to authorize action that would be highly beneficial. Conditions of this sort are bad enough under our present limited representative system; but they will be much worse where direct action by the people is required to a larger extent.

Fortunately in municipal government the recent trend has been away from direct democracy and toward autocratic democracy. We refer to the commission-manager form of city government which has displaced the old council-mayor organization in many cities. One of the reasons why this new form of city administration has proved so successful is that the city manager feels more free to follow his own judgment than does the average city councilman or mayor. He is not continuously holding his ear to the ground, but is relying upon his own opinion as to what is best for the city as a whole.

Most students of political affairs are agreed that the ideal government is an autocracy, provided the autocrat is highly intelligent and wholly fair. But the difficulty of always securing such a ruler has seemed insuperable. Yet how serious have been the attempts to overcome this difficulty? Are there not practical ways of securing governmental executives who approach the ideal of intelligence and fairness? Surely if large business corporations so frequently accomplish this result, there is abundant reason to hope that social corporations may ultimately do the same.

Can Edison's Methods Be Advantageously Adopted by All Engineers?

Several years ago Columbia University virtually lengthened its technical courses to six years by requiring an academic course of three years prior to a three-year technical course. In contrast with this Yale has continued to provide three-year courses in engineering that can be entered by a high school graduate. As between these extremes we prefer the length of course given at Yale.

A six-year college course for engineers is based upon what seems to us an impractical ideal, namely, the conception that a young man upon graduation is to be "broadly educated." In our opinion no man can be broadly educated before he is 35 years of age, even if he studies almost continuously. Why, then, attempt the impossible by striving to impart a broad education to an undergraduate?

Many of the fundamental errors that educators commit are traceable to the false idea that students must become well educated before graduation. If, on the other hand, formal education were conceived to be mainly a process of arousing ambition and inculcating habits of self-education there would result many radical changes in educational courses.

We have frequently given reasons for our belief that our present systems of engineering training fail to produce a large percentage of graduates who are so habituated to study that they will continue to educate themselves as long as they live. Since our colleges are failing to accomplish this result, an opportunity is opened to our engineering societies to train engineers to become continuous students. Engineering societies will do well to investigate the methods used by the Chautauqua Society, for we believe that the same methods can be applied with great effect in giving engineers not only a broader general education but a deeper engineering education.

Training in original research, which has formed so important a part of technical education in Germany, should be made part of the training of all engineers. Whenever this is proposed, it is objected that there is no time for such work in a four-year technical course, and that it is not the proper function of a college to train exceptional men for exceptional purposes. This very objection, however, seems to us to disclose the fundamental error that besets most of our educators, namely, that engineering students are to be taught to do things as others have done them rather than to be trained to search for what others have done as well as for what others have not done. Training in original research stimulates interest and arouses ambition as nothing else does. That alone would justify such training. But, in addition through leading to a search for published information it begets the habit of studying. The study habit unfortunately is not ordinarily acquired by the present methods of teaching, for neither is the student's interest sufficiently aroused nor is he made conscious of his innate ability to gather, analyze and use information.

In another column we give an interview with Thomas Edison wherein it appears that he reads regularly 32 technical periodicals. This, we believe, will be news to most engineers. It should also be exceedingly suggestive. This great inventor evidently owes much of his success to his study of what others have done, perhaps fully as much as he owes it to his own experiments. Now it will not do to dismiss Edison's methods with a trite phrase to the effect that "genius follows no rules," or "the ordinary man can never become a genius by reading about one." Although it may be granted that mere studying will not make a genius, it can not be logically affirmed that an ordinary man can not successfully use the methods that a genius finds advantageous.

Without even a high school education to begin with, Edison has become wonderfully well educated in business as well as in scientific matters, because he acquired the habit of searching both at first hand and at second hand or in the printed page. It is the absence of such a habit that accounts largely for the fact that relatively few engineers attain either eminence in their profession or an income that justifies their having spent four years at college.

Can You Answer This Question?

A class in biography at the University of Indiana was asked: Who was the greatest person in human history? The answers of the 45 students in the class gave Shakespeare the first place. Then in order of composite ranking came Aristotle, Lincoln, Caesar and Washington.

In the published reports of this vote on human greatness we find no mention that a single one of these 45 college students challenged the rationality of the question. Yet the question is absurd, and its absurdity should be evident to anyone who has made even a slight study of logic.

The word "greatest" implies the existence of some unit of measure by which degrees of greatness may be determined. What is the greatest continent? is a question that can be readily answered for the approximate square-mile area of every continent is ascertainable. But "Who is the greatest person in human history?" is unanswerable, because there is no unit of measure of general mental greatness.

It may be practicable to devise units of measure to apply to mental ability in special lines, but even this is doubtful. Thus, what test can be applied to determine the relative mathematical ability of mathematicians? Was Newton, who invented the calculus, a greater mathematician than Descartes, who invented descriptive gemoetry? And if it is well nigh, if not actually, impossible to answer so simple a question, what must be the difficulty where the comparison is to be made between poets, generals, rulers, statesmen, mathematicians, scientists, philosophers, and the hundred and one other broad classes to which mental workers belong? Obviously the task of giving a mental rating to great men of all classes is impossible. Obviously we say, yet it was not obvious to a single one of a typical class of college students, nor to any of the newspaper editors who have commented upon their "vote." It is the prevalence of just such shallowness of thinking, or rather it is such evidence of failure to think at all, that leads us to urge the importance of teaching logic in our colleges.

Dry Season Rainfall Records at Panama.—In order to make comparison of the past dry season, which was abnormally long, with previous dry seasons and use all available records, the following table was compiled for the normal 4-month dry season. This table, which is reprinted from the Panama Canal Record, gives the total rainfall for the different sections and the entire Canal Zone and vicinity for the 4-month dry seasons since American occupation; also the normal 4-month dry season rainfall:

	Rainfall in Inches, Four-Month (January-April) Dry Season.			
Year	Pacific section.	Central section.	Atlantic section.	Canal zone.
1905	5.68	7.17	12.55	8.14
1906	5.97	7.99	10.94	8.22
1907	.40	1.14	7.93	2.80
1908	1.86	4.85	9.13	5.25
1909	8.64	12.93	28.07	15.64
1910	8.84	15.37	23.68	15.71
1911	7.63	6.65	11.10	8.01
1912	1.82	2.55	4.32	2.81
1913	2.88	5.61	13.28	6.84
1914	3.62	4.71	8.30	5.35
1915	7.58	12.80	23.42	11.15
1916	7.06	10.31	12.41	10.02
1917	2.37	3.78	6.19	4.0
1918	7.77	8.28	11.20	8.93
1919	1.30	2.86	1.93	2.99
1920	2.39	2.07	4.10	2.66
Normal dry season	4.25	7.31	12.70	7.89

The World's Rainfall.—The total annual rainfall upon all the land of the globe amounts to 29,347 cubic miles, according to the United States Geological Survey, Department of the Interior, and of this quantity 6,521 cubic miles drains off through rivers to the sea. A cubic mile of river water weighs about 4,205,650,000 tons and carries in solution an average of about 420,000 tons of foreign matter. In all about 2,735,000,000 tons of solid matter is thus carried annually to the ocean.

Method of Procedure in Economical Design of a Pipe Under High Head

By E. W. RETTGER

Assistant Professor Applied Mechanics, [illegible]

In an article entitled "Economical Size of Pipe for a Given Loss of Head" (Cornell Civil Engineer, April, 1919, reprinted in the Canadian Engineer July 17, 1919), the writer developed a method for the economical design of a pipe under high head. In a second article entitled "The Value of a Hydraulic Horsepower at the Wheel" (Cornell Civil Engineer, November 1919, reprinted in Engineering and Contracting, Jan 14, 1920), the writer presented several interpretations that may be given to the formulas derived in the first article.

On account of the inquiries received concerning the details involved in the practical application of the method it seems advisable to explain more fully the use of the formulas derived in these articles.

In the first article cited above several formulas were developed for the determination of the economic size of a pipe (see Equations 1, 2, 5, 6 and 19). The writer prefers the formulas given in the second form, since these do not contain the unknown coefficient of friction, and these formulas will here be called A, B and C.

$$\text{(A)}\quad d = 0.1356\sqrt{\frac{bq}{ntci}}$$

$$\text{(B)}\quad d = 0.1123\sqrt{\frac{bqS}{ncih}}$$

$$\text{(C)}\quad d = 0.1123\sqrt{\frac{bqS}{ncih}}$$

In these formulas, S = allowable unit working stress in shell in pounds per square inch, corrected for rivet holes and water hammer; c = cost of metal per pound, i = interest and depreciation on first cost of pipe; q = discharge in cubic feet per second; t = minimum allowable thickness of shell; n = factor that takes care of the effect that the overlapping of plates has on the amount of metal in pipe; and b is a constant to be determined.

Formula A is to be used for a section under low head, formula B for a section under high head with a constant diameter and with a constant thickness of shell; and formula C for a section under high head with a constant diameter but with a variable thickness of shell. In formula C, h is given by equation 18. (See first article.) If we assume the shell of any section under consideration to vary continuously, h becomes the mean head of this section; that is, h is the center of gravity of the profile of the section under consideration.

With reference to formulas A, B and C, the following remarks may be made:

(a) The division points of the pipe into sections must be given or assumed.

(b) q is the same for all sections—the law of continuity involving steady flow demands this.

(c) The constant b must be the same for all sections and must be determined by considering the whole pipe line or the whole plant depending upon the principle of economy involved.

(d) The other quantities, n, t, S, h, c and i, apply to the individual sections and need not be the same for the different sections.

(e) Formulas A, B and C, as they stand, design for minimum annual cost. If, however, we make i = 1, they design for minimum first cost; if we make c = 1 and i = 1, they design for minimum amount of metal.

(f) The above method is not limited to riveted steel pipe. Corresponding formulas can be derived that are applicable to other kinds of pipes. If any section is to be made of staves, for instance, a suitable formula applicable to wood stave pipe should be used.

(g) In deriving the above formulas it was assumed that if the diameter of the pipe be given a small increase, the increase in all items of cost other than that of the pipe itself will be insignificant when compared with the corresponding increase in the cost of the pipe. In the article cited above, if C = the annual cost of the pipe itself and C' = the annual cost of everything not including the pipe, and it was assumed that the partial derivation of C' with respect to the diameter equals zero, i. e. $\frac{dC'}{d(d)} = 0$ when compared with $\frac{dC}{d(d)}$ (see page 66, Cornell Civil Engineer, November, 1919). This assumption seems to be in accord with facts. The increase in the cost of the supports due to a small increase in the diameter of the pipe seems to be insignificant when compared with the corresponding increase in the cost of the pipe itself.

Each problem is more or less individual in its nature. No single method is applicable, in toto, to all problems. To take a definite problem: Let us assume that it is required to determine the economical pipe for a given loss of head due to friction, and that this pipe will be found to have a large diameter (say, 6 ft. to 8 ft.). Let us also assume that the pipe is to be made of riveted steel and that it is to consist of three sections. The first (upper) section is to have a constant diameter and constant thickness of shell, while each of the other sections is to have a constant diameter but variable thickness of shell.

For convenience it will be assumed that minimum first cost is desired. This is equivalent to making i = 1 in the above formulas. [See remark (e) above.] The following method of procedure suggests itself.

(1) From previous experience, a rough approximation to the size of the pipe may be made.

(2) This rough approximation to the size of the pipe having been made, determine the approximate effect of water hammer and the efficiency of the joints, and adopt a proper choice for S the corrected unit working stress in the metal. Also determine for each section the value of c, the cost of the pipe per pound of metal. Due to the inaccessibility of the upper part of the pipe line, it may happen that the upper section will cost considerably more to lay per pound of metal than the lower sections. In c any item of cost may be included that is (even approximately) proportional to the weight of the metal in the pipe.

(3) Select convenient division points of the pipe for the purpose of dividing the pipe into sections (first approximation).

(4) Determine a first approximation to the value of the constant b. This may be done by successive trials, or (if a given total loss of head h' is given or assumed) directly as follows:

Assume the friction head for a riveted steel pipe of length l and diameter d to be given by

$$h' = 0.00050\frac{v\,l}{d}$$

If v be eliminated by means of the relation q = Fv = ¼ π d²v, this last expression may be written

$$h' = \frac{0.000810 6 q\,l}{d}$$

The total loss of head for the pipe (three sections here) then becomes

$$h' = 0.0008106q\left(\frac{l}{d_1} + \frac{l}{d_2} + \frac{l}{d_3}\right)$$

If in this last expression we substitute the values of d_1, d_2 and d_3 as determined by the appropriate formulas, we obtain an equation with the constant b as the only unknown. In the particular problem selected, formula C should be used to determine d_2 and d_3. If the first section is under high head (constant thickness of shell) formula B should be used to determine d_1.

Substituting the value of d_1 as determined by B, and the values of d_2 and d_3 as determined by C, this last expression becomes, solving for b,

$$b = \frac{22.64}{h'}\left[\left(\frac{h}{S}\right)_1 l_1 + \left(\frac{h}{S}\right)_2 l_2 + \left(\frac{h}{S}\right)_3 l_3\right]$$

where h' is the loss of head (in the whole pipe) given or assumed, h is the highest head, the first section is under, and h is the mean head of the second, or third section.

(5) With this value of b, determine the diameters of the several sections by means of the appropriate formulas (B or

C), using the values of c and S as approximated above. This gives a second approximation to the size of the pipe.

(6) For each section, revise if necessary the values of c, S and n and the location of the division points.

(7) If considerable revision is necessary, use the revised values for c, S and n, and the new location of the division points and redetermine the constant b. Then determine the final diameters of the sections.

(8) It is frequently specified that a certain thickness t" shall be added to the thickness of the shell to take care of rust and wear. Although this additional thickness is not to be considered when determining the strength of the pipe, it may to some extent affect the economical design, especially if the upper section (say) is to be designed for low head (or is to be made of wooden staves) and the other sections are to be designed for high head. If the upper section is to be designed for low head, the minimum allowable thickness of shell t' may include t". Unless t" is also considered in connection with the sections under high head, too much weight may be given to the upper section. If desired, the effect that this additional thickness t" has upon the economical design may be included in the following manner:

Let h" = head on a pipe of diameter d and thickness of shell t", then

$$t'' = \frac{h''wd \times 12}{2 \times S}$$

where $w = \frac{62.5}{144}$; S = corrected unit working stress (same as used above), and d = diameter in feet. From this we obtain

$$h'' = \frac{St''}{2.60d}$$

As soon as a first or second approximation to the diameter d of a section has been found, h" is known with sufficient accuracy for practical purpose.

Now add this h" to the h or h. in the formulas B or C and redesign. This is equivalent to increasing the head on each section of the pipe (other than the sections under low head) just enough to require this extra thickness t". In this way the effect of t" on the economical design may be included.

(9) It may be added that this problem is one of "Maxima and Minima" in the calculus sense. Consequently, the diameters may be changed finally by several per cent without affecting the economy appreciably, provided the total loss of head remains the same. One diameter, therefore, may be increased a little and another correspondingly decreased so that the total loss of head remains the same. Such a change will not affect the economy appreciably.

The writer does not mean to suggest that the foregoing method of procedure is necessarily the best, or that it is applicable to all cases. He hopes, however, that most of the inquiries he has received are here answered.

Surveys Under Way for All-American Irrigation Canal.—Headquarters have been opened at El Centro, Calif., for surveys for the All-American Canal in the Imperial Valley proposed by the Kinkaid Bill. Surveys will be made of the land irrigable under the proposed All-American Canal and of the canal itself, and from the data obtained a report will be compiled for congress under the provisions of the Kinkaid Bill. By the building of an All-American Canal, Imperial Valley would be assured of an easily controlled water supply. At present the irrigation canal for the valley is for many miles in Mexico and that country has supervision over that part of the canal and so has control over the water supply of Imperial. The Imperial irrigation district cares for the system but the Mexican government receives 50 per cent of the water carried. The danger from flood under the present system is considered great. The proposed All-American Canal would be 210 miles in length, would cost about $30,000,000 and take three years to build. The initial expense is to be borne by the government and the repayment by the valley made under any plan asked. The water would be taken from the Colorado River at Laguna dam and led along the border to Calexico thence along the east rim of the valley south on the western side of the valley. H. I. Gault of the U. S. Reclamation Service is in charge.

Irrigation Developments in Oregon

During the past month of June considerable progress has been made in irrigation development in Oregon, notwithstanding the adverse condition of the bond market. However, most of the activity has been along the line of investigations preliminary to the issuance of bonds. Owing to the unfavorable condition of the money market, irrigation districts in general have been urged to withhold bond issues until conditions were more favorable, excepting in those cases where construction work is in such condition that failure to proceed would entail a loss.

Arrangements have been made whereby bonds of the North Unit Irrigation District in the amount of $50,000 have been purchased by the Ralph Schneeloch Co. of Portland for the purpose of making a construction survey and preparing plans for the reclamation of the 100,000 acres of land in the district. The reclamation of this project will involve the construction of the Benham Falls Reservoir, upon which Professor W. O. Crosby, geologist of Massachusetts, recently made a favorable report. It is planned to utilize the Benham Falls Reservoir for the reclamation of all the units of the Deschutes Project which aggregate 200,000 acres. The investigations will be in charge of an engineering commission, composed of A. J. Wiley of Boise, and Fred Herman of San Francisco, representing jointly the District and the Ralph Schneeloch Co., the latter having an option on the remainder of the District bonds.

Investigations are under way to revise and bring up to date the information secured by the State and Federal Government on the John Day Project. The John Day Irrigation District was organized in 1919, and has employed the firm of Lewis & Clark, engineers, of Portland, to make the necessary surveys. This district includes some 300,000 acres of land lying along the Columbia River in Gilliam County, Morrow County, and Umatilla County, and is one of the largest projects in Oregon, the officers of the district being Clay C. Clark of Arlington, President, and F. R. Brown of Heppner, Secretary.

The Harney Valley Irrigation District, which includes about 86,000 acres of partially irrigated land, lying along the Silvies River in Harney County, has arranged with the engineering firm of Baer & Cunningham of Portland to make the necessary surveys and prepare plans for the construction of reservoirs on Silvies River for the complete utilization of the waters of this stream, and to give a full water right to the partially irrigated lands. Surveys are now under way on this project.

An investigation was made during June by the Irrigation Securities Commission, of the Mountain Sheep Irrigation District in Wallowa County. This district contemplates the irrigation of approximately 10,000 acres of land with the waters of the Big and Little Sheep Creeks, and action on the certification of $150,000 in bonds is awaiting the submission of additional information.

An investigation has been ordered by the Irrigation Securities Commission of the Summer Lake Irrigation District in Lake County, which district contemplates the irrigation of approximately 7,000 acres of land lying along Summer Lake, with the waters of the Ana River. This district has requested the certification of $260,000 in bonds.

Very gratifying reports have been received from the Warm Springs Irrigation District, which has stored 52,000 acre feet of water this season, for the first time, in its new reservoir, which together with the regular flow of the Malheur River affords ample water for the irrigation of the 30,000 acres of land in the project, and reports indicate that crops will be excellent this season.

One unit of the Talent Irrigation District in Jackson County, has been completed and water has been applied to the lands thereunder. Work on the second unit of this project has been postponed for the present on account of the unfavorable conditions for the sale of bonds. The district, fortunately, is in a position that it could suspend further construction without adversely affecting it.

The preliminary pumping units on the Grants Pass Irrigation District in Josephine County have been completed, and water is being delivered to the lands on this district. Plans have been approved for the construction of the permanent gravity system, and work on this system is under way.

Performance of Direct Connected Turbine-Centrifugal Pumping Unit on Irrigation Project

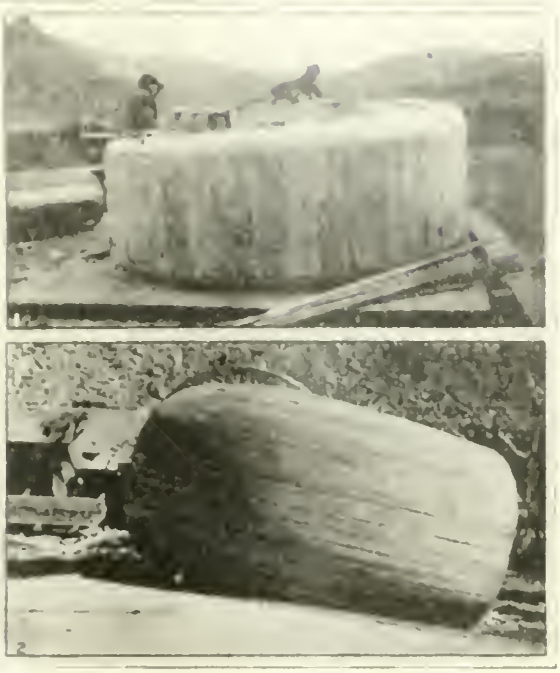
One of the latest pumping installations made by the U. S. Reclamation Service is the Price-Stub pumping plant located on the Grand Valley Project near P[illegible]. The plant was constructed early in 1919 for the purpose of supplying water to the Palisade and Mesa County Irrigation Districts which include 8,400 acres of land lying at the east end of the Grand Valley, between Grand Junction and Palisade. The plant is a good example of the most modern type of direct connected hydraulic pumping machinery and is of special interest on account of the high efficiency obtained. For these reasons we are reprinting below from the Reclamation Record a description of the plant written by S. O. Harper, Project Manager of the Grand Valley Project.

The plant is located adjacent to the project main canal at the outlet of Tunnel No. 3. A check structure across the canal controlled by wooden flashboards is combined with the tunnel outlet to form the forebay. The penstock is of concrete 4½ ft. square, and a by-pass conduit 3 ft. in diameter is provided to permit delivery of water to the Price Ditch at times when the plant may be shut down for repairs. The discharge line consists of a 30-in. machine banded wood-stave pipe 210 ft. long. The building is of concrete construction with corrugated iron roof.

The pumping machinery consists of a 25½-in. vertical turbine direct connected to a 24-in. special centrifugal pump. The turbine was manufactured by the S. Morgan Smith Co. of York, Pa., and the pump was made by the Byron Jackson Iron Works, Berkeley, Calif. The net head on the turbine is 17 ft., and it is designed to develop 125 HP at 210 revolutions per minute with 77 second-feet of power water. The pump was guaranteed to deliver 25 second-feet of water against a head of 31 ft.

The turbine volute and the draft tube are cast in concrete, so designed as to pass the water through the turbine with a minimum friction loss. The forms for these parts were quite complicated, as the accompanying illustrations will indicate, and their construction required considerable ingenuity on the part of the construction force.

The speed ring is of cast steel [illegible] extension which forms the [illegible] for the pump. The top of the pump casing forms the [illegible] thrust bearing which carries the weight of the rotating parts of the turbine and pump. In addition to the main thrust bearing, three guide bearings are provided for the shaft. The oiling system consists of a supply tank, a filter tank, and two rotary pumps. The oil is fed from the supply tank by gravity and after passing through the bearings is pumped into the filter tank from which it is lifted to the supply tank and again fed to the bearings. The system is automatic in its operation and a new supply of filtered oil is continuously

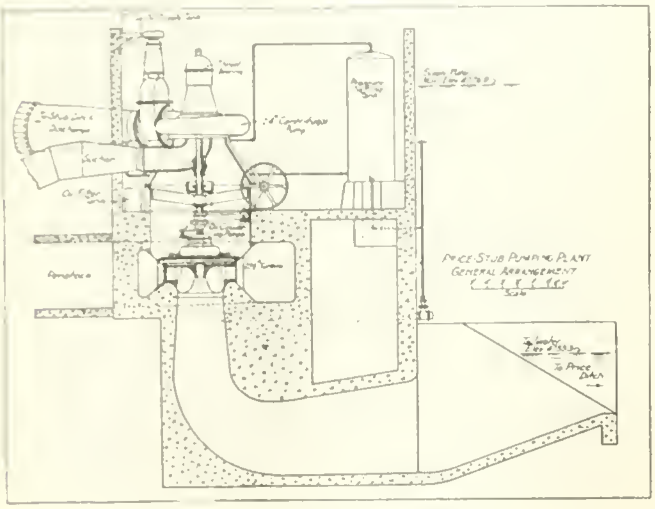


Top View: Form for Turbine Volute; Bottom: Form for Draft Tube.

View of Price-Stub Pumping Plant. Stub Ditch Flume, Forebay, Project Main Canal, Pumping Plant and Price Ditch in Foreground.

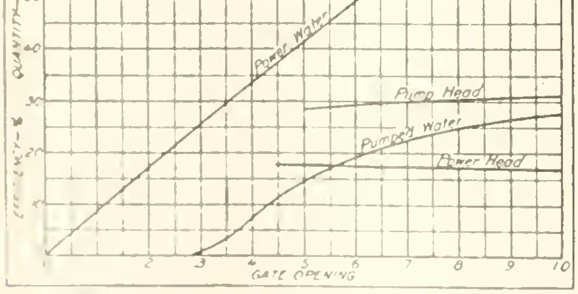
fed to the bearings. With this arrangement of bearings, all moving parts are readily accessible.

During certain portions of the year the water of the Grand River contains a large quantity of silt, which is destructive to the submerged parts of turbines and pump. This condition was given special consideration in the design of the machinery for the Price-Stub plant, and provision was made for protecting the moving parts against wear and for renewing readily those parts which are exposed to excessive wear. A pressure settling tank is provided to supply clear water for the pump stuffing-box bearings. Removable steel wearing rings are provided for the running joints of turbine and pump, and all bearings are supplied with detachable bronze sleeves.



General Arrangement of Pumping Plant.

Inasmuch as the plant contains only one unit and interruption in its operation during the irrigation season would mean serious loss to the farmers dependent upon it, a supply of spare parts is kept on hand for emergency use. This supply includes all parts which might in any probability be required to safeguard against a shutdown during the season, such as turbine shaft and runner, pump shaft and impeller, wearing rings, bronze sleeves, and wearing parts for bearings. With this supply on hand any replacement which may be necessary can be made with only a short suspension of operation.



Efficiency Tests of Price Stub Pumping Plant.

The construction of the plant was started in January, 1919, and completed far enough to permit it to be put in operation on April 10. The work was handled entirely by Government forces. On account of the limited time available between irrigation seasons, the work had to be pushed as rapidly as possible. The excavation was handled with a drag-line excavator. Unfavorable weather added to the difficulties, and much of the concrete was placed with the temperature below freezing, making it necessary to take special precautions for its protection. The concrete was mixed in a small mixer set on top of the canal bank in such a position that practically all of it could be spouted directly into the forms. Sand and gravel were hauled a distance of 1½ miles through Tunnel No. 3 by motor truck.

The total cost of the plant and appurtenant structures was $46,697.83, distributed as follows:

Check and forebay	$10,888.16
Penstock	2,440.91
By-pass	1,135.81
Building	10,547.96
Hydraulic machinery and installation	18,412.22
Discharge pipe	1,195.96
Tailrace	2,076.81
Total	$46,697.83

The final test of the plant, which was made after it had been operated for two months, showed remarkably high efficiency for the entire range from 0.5 to full gate opening. The maximum combined efficiency of the unit was 68.3 per cent at 0.7 gate opening. Separate efficiencies as high as 88 per cent were indicated for the turbine and 82 per cent for the pump, but the combined efficiency was not so high as these figures would indicate because the points of maximum efficiency of the two units were not coincident. The results of the tests are shown graphically in the accompanying diagram.

The information supplied by the diagram is of interest in indicating the output of a combined unit of this kind through the entire range of operation. Numerous data are available on the individual performance of both turbines and centrifugal pumps, but the available information on the performance of a complete direct-connected unit is very limited. As the tail-water from the plant is used for irrigation, it is necessary at the beginning of the season when the irrigation requirements are small to supply an excess of water to the lower ditch before the centrifugal pump will attain sufficient speed to begin to throw water into the upper ditch. Unless there is ample water for this purpose and adequate wasteway facilities are available in the lower ditch, it might be necessary to install two pumping units in order to obtain sufficient flexibility. In the test of the Price-Stub plant the pump began to deliver water into the Stub ditch when the turbine was operated at 0.3 gate opening, and the irrigation requirements of the two ditches were such that it was necessary to feed surplus water to the lower ditch for a period of only 10 days at the beginning of the season.

The service during the season of 1919 has demonstrated that a plant of this type is not only highly efficient but is very dependable and economical in its operation and maintenance. During the seven months of the irrigation season no shutdowns were necessary except for a few short periods to remove sticks and trash from the pump. Only one man was required to handle the operation, and a house located adjacent to the pumping plant is provided for his use. An inspection of all bearings and other moving parts at the close of the year showed no appreciable wear and the machinery after the first season's operation was in excellent condition.

Summary of Work of U. S. Reclamation Service

A summation of the work of the Reclamation Service to Dec. 31, 1919, shows that the projects now under way or completed embrace approximately 3,200,000 acres of irrigable land divided into about 67,500 farms of from 10 to 160 acres each. During the year, water was available from government ditches for 1,935,278 acres on 41,836 farms, and the government was under contract to supply water to approximately 1,690,000 acres. The available reservoir capacity at this time was approximately 9,432,000 acre-feet.

The Service has dug 12,489 miles of canals, ditches, and drains and excavated 95 tunnels with an aggregate length of more than 27 miles. It has erected masonry, earth, rock-fill, and crib storage and diversion dams with a total volume of 13,729,343 cu. yd. It has built 7,041 bridges with a total length of over 30 miles. Its culverts number 9,196 and are 60 miles long. There are now in operation 509 miles of pipe line and 103 miles of flumes.

The Service has built 983 miles of wagon road, 83 miles of railroad, 3,141 miles of telephone lines, 651 miles of transmission lines, and 1,424 buildings, such as power houses, pumping stations, offices, residences, barns, and storehouses. The power developed amounts to approximately 60,000 hp.

Studies for Proposed Extensions to Sewer System of Small City

By W. D. P. WARREN
Of Miller, Holbrook, Warren & Co., Consulting Engineers, Decatur, Ill.

The rapid growth of the city of Decatur, Ill., both in the residence and industrial sections, so far exceeded the development of the present sewerage system that instructions were given by the City Commissioners in 1919 that comprehensive plans be prepared showing a method of providing sewerage for the city.

The necessity for the preparation of such plans was brought to the attention of the officials by petitions presented from various sections of the city asking that sewers be extended or provided to serve the territory petitioning therefor. As is the case in many cities, the old sewers had been extended to provide for additional territory, until they were in many cases severely overloaded.

As consulting engineers for the city, the foundation of our plan was an accurate contour survey, covering all territory likely to be included within the city limits during the next 30 or possibly 40 years. These surveys were completed late in the year 1919, and cover an area somewhat greater than that of the city at the present time.

Another feature of our investigations was a study of some of the old sewers of Decatur and their present effective capacities. We consider this of importance in the design of new sewers, as it affords a more intelligent basis for rational design.

It is extremely important in the study of extensions to the sewerage system of Decatur, as of any other city, to consider the future development of the city as a whole. This fact is readily apparent here when it is realized that any plan for future sewerage for Decatur is very closely related to improvements contemplated by the Sanitary District of Decatur, by the City Planning Commission, and by the city proper in connection with the development of the water impounding project.

Inasmuch as the problem here is in some ways typical, it may prove of interest to others to know the general lines along which our studies were conducted, and also our recommendations in the matter.

One feature which made the plan at Decatur somewhat unusual was the necessity of disposing of all drainage at such points below the city that pollution of the proposed impounding reservoir would not be possible. The drainage of the city naturally flows to the south and west, the Sangamon River, with a water shed area of 860 square miles, lies about ½ mile east of the present city limits, and flowing westerly along the southern boundary of same. Also the portion of the city north of Garfield Ave., being the territory particularly in need of sewerage, has a fall toward Stevens Creek, which enters the Sangamon River at a point about 1½ miles below the city.

The impounding reservoir mentioned above will probably be constructed during 1920, and will be formed by the erection of a masonry and earthen dam across the Sangamon Valley at a point just south of the city.

The new territory to be sewered in the immediate future lies in the eastern and northern portion of the city and beyond, and generally speaking, above the built up sections which are now sewered.

Original Plans for Sewerage.—In 1881, Mr. Benezette Williams, a civil engineer, of Chicago, was employed by the city of Decatur to prepare plans for a comprehensive system of sewers.

The original plan of Mr. Williams has been generally adhered to, although the territory contemplated to be included at that time has been greatly exceeded. This has been due to the unexpected growth of the city and failure of the proper officials to anticipate this growth and provide the necessary additions and extensions to care for the same from time to time. As a matter of fact the original plan considered and provided drainage for territory which at that date was far outside the city.

The present combined system at Decatur as designed by Mr. Williams, contemplated the construction of only one storm water inlet basin to the block, such inlet basin to be connected to the main sewer by an 8-in. pipe. In his report he specifically stated that with the area specified it would be necessary to retard the entrance of storm water in some manner, otherwise the sewers would be gorged at times of heavy rainfall. Because of the rapid growth of the city and the construction of pavements on many streets, additional catch basins and storm water inlets have been connected to the sewers so that they are overloaded with rains generally classed as ordinary.

When we consider, however, that the original system has provided drainage for the city over a period of about [illegible] years with only occasional damage, except in the case of unusual storms, we are really proud of the profession and of the ability of the engineer, Mr. Benezette Williams, who so accurately predicted the requirements of the city and provided therefor in such an economical manner. The original report of Mr. Williams, written in long hand, is still in the files of the City Engineer's office.

Study of Run-Off Data.—In connection with the design of the proposed extensions, we considered it of great importance to determine the present effective capacities of the old sewers for storms of ordinary duration, and therefore undertook to compute the proper sizes by the Rational Method of Sewer Design in order to make a comparison of the present sizes and of the sizes required.

The urgent demand for sewers in the newer portion of the city prohibited the taking of accurate measurements of the flow in old sewers, and as no previous measurements were available, it was considered extremely desirable to obtain such information regarding the effective capacities of old sewers as might be otherwise readily ascertained. Knowing the effective capacities of the old sewers as indicated by the experience of recent years, the proper factors could more definitely be determined for the proposed extensions.

In making a study of the old sewers, a table was prepared showing the size, grade, drainage area, rainfall, length of sewer, time of run-off and run-off factor.

A most interesting figure was obtained as to the population per acre in the territory in the city which is now sewered. Studies by Mr. Emil Kuichling and by Prof. H. N. Ogden, indicate that the percentage of imperviousness varies with the intensity of population. Careful computation of the area of the city as a whole shows the acreage now sewered to be 2,900 acres and the population to be 46,400, or an average of 16 per acre. From tables given by Metcalf and Eddy, Vol. I, American Sewerage Practice, pages 272 and 276, it is observed that the population per acre is generally estimated somewhat higher than this figure.

Assuming that the percentage of pervious and impervious areas are as indicated by the studies of Kuichling and Ogden, and that they bear a direct relation to the population per acre, we will have approximately 16 per cent of impervious area, and 84 per cent of pervious area. These figures are very conservative and will give somewhat less capacities than are ordinarily considered necessary for sewers in cities of this class.

In fact, estimates of the percentage of impervious and pervious areas, based on a population of 16 per acre, with actual figures on the area of house roofs, pavements, walks, driveways, sheds, etc., indicate that the per cent of impervious area should be at least twice this amount. This fact should receive careful consideration, especially in the design of lateral sewers.

Present and Subsequent Sizes for Sewers.—Table I shows present and suggested sizes for old sewers. The required capacities of old sewers was computed on the basis of an average population of 16 per acre, with proper allowance for local conditions. It was assumed there is 85 per cent run-off on the impervious, and 10 per cent run-off on the pervious areas for ordinary storms, and that the areas have average porosity and moderate slopes.

A uniform rate of run-off equivalent to 2.2 cu. ft. per second per acre was used for all times of concentration up to 30 minutes, and decreasing rates for longer times.

The maximum rate of flow of storm sewage in cubic feet per second was derived by multiplying together the area of the sewer water shed in acres, the maximum rate of rainfall in inches per hour and the percentage of maximum run-off. Curves by Prof. A. N. Talbot, showing ordinary rainstorms in the Central States, were used and these were also compared with curves prepared by Pearse & Greeley in connection with their studies for sewage disposal at Decatur.

TABLE I—DATA ON DECATUR SEWERS

Name of Sewer.	Area, Acres.	Grade	Size.	Cap. c. f. s.	Cap. c. f. s.	Size.	Length	Time, Min.	Rainfall Inches	Per cent Run-off.
	Present Size and Capacity of Old Sewers*				Proposed Size and Capacity of Sewers					
Warren St. above Marietta	200	0.20	42x63	66	80	[illegible]	5200	34	2.1	.19
Warren St. above Grand.	70	0.20	28x42	22	28	32x48	3200	31	2.2	.18
Jasper St. above North	320	[illegible]	42x63	76	100	48x72	6200	34	2.0	17
Jasper St. above Sangamon	160	0.20	36x54	52	60	38x57	4600	30	2.2	.17
Union St.† above Prairie	220	0.15	36x54	36	87	48x72	7000	41	1.8	.22
Clinton St. above Sangamon ..	115	0.25	30x45	28	40	24x51	5400	37	2.0	.18

*Old sewers designed in 1884.
†Union Street sewer irregular—greatly overloaded.

The above table shows a somewhat regular proposed increase in size of sewers, with the exception of the Union St. sewer. The Union St. sewer is notoriously inadequate and has been the source of much complaint by property owners along its course. In our opinion steps should be taken at once to relieve this situation.

From a study of the size and capacity of old sewers as given in this table it is seen that the area in acres, grade, size, length, time of flow and capacity are all known factors and that the only elements of uncertainty are the rainfall in inches per hour and the per cent of run-off. Inasmuch as the rainfall may be quite accurately determined from rainfall tables prepared for this immediate territory, there remains then only one factor to be determined—that is, the percentage of run-off. Adjusting the run-off factor in order to obtain a capacity in cubic feet per second as shown for example by the Warren St. sewer, we would then have a proper figure as indicating the per cent of run-off, for similar areas, provided, of course, that the Warren St. sewer as now constructed is of sufficient capacity.

Also according to the studies of Kuichling and Ogden, the percentage of imperviousness and the resulting run-off should vary with the intensity of population. In this case we would be compelled to assume a population greatly below the actual population in order to reduce the run-off figure to a point where we could meet the known capacity of the sewer.

The run-off factor of 19 per cent as finally adopted for this particular area proposes a slightly larger capacity in cubic feet per second and therefore a slightly larger sewer. The increase proposed appears entirely rational from our knowledge of the local conditions and requirements, being somewhat conservative, however, as herein before indicated.

New Territory.—The contour surveys were made during the year 1919, showing the territory east of the city limits as far as the Sangamon Valley; north of Garfield Ave. and along the entire north side of the city, covering a new area about 1 mile in depth; also along the western limits of the city to Stevens Creek, which flows south at a distance of about 1 mile west of the city and enters the Sangamon River southwest of same.

The Sanitary District of Decatur was organized in 1917, and through its engineers, Pearse and Greeley of Chicago, has prepared comprehensive plans for a disposal plant near the intersection of Stevens Creek with the Sangamon River, southwest of Decatur, and has also prepared plans for an intercepting sewer along the southern boundary of the city. The upper terminus of this proposed intercepting sewer is located at the intersection of the Broadway sewer and the extended line of Spring St., and will be 6 ft. in diameter.

For convenience the new territory to be sewered has been designated as follows: The East Sewer District, lying east of the present city limits and extending east to the Sangamon Valley, having its outlet into the 6-ft. sewer to be provided by the Decatur Sanitary District, the separate corporation above mentioned. The area of this district is approximately 2,690 acres, and is quite rolling, as it borders on the Sangamon Valley and the proposed impounding reservoir. It is only thinly populated at the present time; however, it is assumed that the construction of the impounding reservoir will cause an early development.

Another district is known as the John's Sewer District and lies southeast of the center of the city, but entirely within the built-up area, although it is very little built-up and has no sewerage at the present time. An interesting point in connection with this district is that the natural drainage therefrom is north, while as a matter of fact the city is so built-up and sewered at the present time, that it will be necessary to carry the sewers through the divide to the southwest and connect to an old sewer known as the Cantrell St. sewer. The area included in this district is a residence section and comprises 172 acres.

Another district is designated as the North Sewer District and includes territory north of Garfield Ave., the direction of drainage being naturally to the west into Stevens Creek. This area includes both industrial and residence sections and is in need of immediate relief. The area is approximately 475 acres.

The other district is known as the West Sewer District, lying west of the city limits and extending therefrom to Stevens Creek. As drainage in this direction is not a difficult matter and as there is no immediate demand for relief here, detail studies have not been made. However, contour surveys show its relation to other areas sewered or to be sewered.

These districts will be further discussed under the following headings:

East Sewer District.—As noted above, the East Sewer District comprises the area lying east of the present city limits and along the border of the proposed impounding reservoir. With its area of 2,690 acres it would be a most expensive proposition to sewer were it necessary to carry the entire sewerage therefrom to a point below the proposed dam. Alternate plans presented to Mr. Paul Hansen, formerly engineer with the Department of Public Health, were considered, and valuable advice was given us in this matter by Mr. Hansen.

The contour of the ground is such that practically the entire storm sewage, from 2,050 acres, of this district will drain naturally to the Sangamon Valley and the borders of the impounding reservoir, and as it is certain that the area in the vicinity of the reservoir will be well built-up, it is readily understood that unusual precautions will be necessary here to prevent pollution of the city's water supply.

As the larger portion of this area is outside the present city limits, no detail plans for immediate relief have been developed; however, it was thought necessary, in view of the possible building-up of the area in a matter of a very few years, that it should be considered in its relation to the sewerage of the city as a whole.

Tentative plans contemplate the construction of a sewer 6 ft. in diameter at its outlet and where connection is made with the 6-ft. sewer to be constructed by the Sanitary District, the size of the sewer to be so reduced as it extends eastward as to provide most suitable relief for the storm sewage of the district. Under this plan a strictly sanitary sewer would be constructed beneath the storm sewer, designed to provide sanitary sewerage for the entire 2,690 acres, thereby insuring positive separation of storm and sanitary sewage. Other mains or branch sewers would enter both the sanitary and storm sewers at various points along the route of same. The main sewer with its sanitary sewer constructed underneath, would in reality be an intercepting sewer, being located approximately along the contour, 10 to 20 ft. above the proposed level of the reservoir. Another feature of importance in connection with this plan is that of diverting storm sewage during times of heavy rainfall.

As indicated above, our plan proposes the construction of a storm sewer with a strictly sanitary sewer underneath. This sanitary sewer should have capacity sufficient to provide sewerage for an area of 2,690 acres or a population of approximately 40,000. While the area to be served by the sanitary sewer in this district is 2,690 acres, the area to be drained by the storm sewer will be only 2,050 acres, as the north 640 acres in this East Sewer District should be taken in the direction of its natural outlet, which is north.

We therefore must provide a storm sewer with its outlet into the intercepting sewer of the Sanitary District, to properly drain this area and at the same time protect the reservoir. The expense of a large storm sewer such as would serve 2050 acres would be very great. However a plan considered feasible by Mr Hansen is to construct relief sewers along the route of the main storm sewer at such points that storm water can be discharged directly into the reservoir, thus maintaining the minimum size of sewer. It will be necessary in so doing to provide that the relief sewer receive the storm water from the upper portion of the main storm sewers, thereby allowing the minimum of objectionable storm water to enter the reservoir. It must be understood that this plan is based on the assumption that the storm drainage will be greatly diluted by the time the storm sewer is filled to capacity, and that such overflow as occurs will be discharged from the upper portion or section of the storm sewer.

Considering the size storm sewer which would be required on a conservative basis to provide an outlet for the storm drainage of this area, assuming that no sewage was permitted into the reservoir, it is computed that a [illegible] sewer would be necessary. It is therefore seen that a method of providing a smaller sewer with overflow at certain points is very desirable in order to reduce the cost and in order to prevent the sewage from a combined sewer from being thrown directly into the reservoir in case of the flooding of same during unusual storms.

The proposed plan of separate sewers appears very feasible for this district.

John's Sewer District.—The John's Sewer District comprises an area of 172 acres, and as previously noted will drain through the divide, against the natural fall of the district and be connected to the present 48-in brick sewer at the intersection of Cantrell St. with Webster St.

The population of this district has been estimated at 16 per acre, the average for the area of the city now sewered. By using a run-off factor of 18 per cent as determined by the study of old sewers, we find the size required will be 48-in on the basis of a .3 grade. This size would permit connection with the Cantrell sewer by a sewer of equal diameter, however, as a .3 grade will require a depth of excavation of about 26 ft. through the divide, and will also bring the sewer to an elevation at Cantrell St. which would not permit of connection with the present 48-in sewer, it was considered that the most economical plan would be to use a 54-in. sewer on a .15 grade, thereby providing equal capacity.

This plan will also effect a substantial saving in the cost of excavation and permit connection with the present 48-in sewer at Cantrell and Webster Sts. As the 48-in. sewer has a heavy fall from this point it will readily carry the drainage delivered by the proposed 54-in. sewer.

The plan of sewerage provided for the John's Sewer District contemplates a combined system, being necessary because of the impossibility of removing the storm sewage in the direction of its natural outlet.

North Sewer District.—This district lends itself naturally to the plan of a separate system, as the storm water can be disposed of immediately outside the built-up section, and the contour of the ground is such that storm sewage can be collected at low points without constructing storm sewers the full length of each block. The grade of the sanitary sewers is such that minimum sizes may be used. The run-off factors derived by a study of old sewers were used in computing the necessary size of main storm sewer for this district.

As an example, the size required at the manhole on Union St., where the drainage from the east enters, is 54 in. This was determined by computations on the basis of an area of water shed of 310 acres, grade of .3, length of sewer 7,900 ft., and time of flow from most remote point on water shed to point under consideration of 37 minutes. The run-off factor of 18 per cent was used in the design of this sewer. Preliminary plans as above outlined were submitted to Mr. Paul Hansen, and his approval of the separate system secured.

The advantages are readily apparent, as sanitary sewage can then be treated to a much better advantage, independent of whether the disposal plant is located northwest of the city, on Stevens Creek, or whether the sewage is carried a distance of 3 or 4 miles down Stevens Creek to the main disposal plant to be constructed by the Decatur Sanitary District. Also another advantage of the separate system is that the cost of sewerage for the district is greatly reduced.

For the present it is planned to [illegible] plant on Stevens Creek northwest of the city [illegible] sewage such treatment only as will render the effluent unobjectionable, the thought being that eventually a sanitary sewer will extend from the main disposal plant of the Sanitary District near the point where Stevens Creek enters the Sangamon River, connecting with the proposed present outlet of the North Sewer District and also intercepting all sewage from the West Sewer District.

While the plan of one common disposal plant for the sewage of the city as a final solution of the sewage treatment problem has not been approved by the Trustees of the Sanitary District, it appeals strongly to the writers and will no doubt be found the most practicable.

West Sewer District.—This district should properly include the territory between the city limits on the west of Decatur and Stevens Creek. As it is little built up at the present time and is so fortunately situated with reference to outlet and disposal plant no special mention of it, other than above, need be given.

Rational Method of Design.—It is interesting to note that many cities are now following the Rational Method of Sewer Design, and in this connection, we believe the study of the present effective capacities of the old Decatur sewers is of great value in the design of new ones.

It is generally recognized by sanitary engineers that the design of sewers is far from an exact science, and that best results are to be obtained only by application of the known engineering principles which govern and by careful consideration of all available local data which may apply.

It is our opinion that the proportion of impervious area will be somewhat increased during the near future, due to the growing tendency to use concrete or other impervious material for driveway and street surfacing purposes, and while no special allowance has been made therefor, it should be considered as a factor.

Selection of Proper Size of Meter for Various Services

Two interesting papers on this subject were presented at the National Convention of the American Waterworks Association. One of these describes the experiences of the Passaic Water Co., Passaic, N. J.; the other the experiences of the Spring Valley Water Co. of San Francisco, Calif. Abstracts of this paper follow.

Experiences of Passaic Water Co.

By W. R. Edwards, Assistant Superintendent.

It is not uncommon today, when looking into the records of the average water department, to find that they have meters entirely too large to warrant their installation and maintenance. Recently, on examining the meter records of one of our own water interests, so far distant from the main office that little attention has been given to it, we found inconsistencies quite typical of those seen in a dozen other plants, both privately and municipally-owned; viz., ⅝-in. meters doing two or three times as much duty as 1½-in. and 2-in. meters. The reason for this is that the size of the meter applied for was usually installed, or the size of the service connection was considered the controlling factor, instead of obtaining all possible information of probable consumption as a basis for decision. No time is now being lost in correcting this situation, and a genuine control of meter sizes will henceforth be maintained.

Another plant (municipal) with which I happen to be familiar, has increased its revenue during the past year approximately 60 per cent, due to giving the meter system a general overhauling, putting in condition the bad meters, and reducing the size of many others, thus giving a more complete registration of the water.

As a result of our 20 years' experience of meter setting, we have adopted a definitely-established schedule of sizes, and only under very special conditions do we deviate from it. In the early days of metering, we became so well supplied with the large sizes that it has not been found necessary to buy a meter larger than ⅝-in. size in more than 10 years, and during this decade, no small number of manufacturing establishments, dye houses, etc., have become of record with us.

That a wrong impression may not be conveyed, the following list of various sizes of meters in service on January 1, 1920, is representative of the larger sizes we had in service 10 or 20 years ago, but, of course, we maintain only the most modern types which we have arranged for on the basis of exchange. The sizes are:

⅝-in.	¾-in.	1-in.	1½-in.	2-in.	3-in.	4-in.	6-in.
20,573	519	210	66	63	63	19	5

In metering multiple-family houses, we find a ⅝-in. meter adequately serves the requirements up to six families, each having a full or complete set of fixtures. ¾-in. meters serve 12 families, 1-in. meters serve 24 families; 1½-in. meters serve 40 families or more. It is obvious that we put our meters assiduously to work, but they are fully equal to the task, and when an analysis is made it is seen that they are not overtaxed in any way.

It is quite well agreed that the average family consumes not over 2,000 cu. ft. per quarter, and at this rate six families will consume 12,000 cu. ft. per quarter, 132 cu. ft. per day, and a further reduction equals 0.092 cu. ft., or 0.69 gal. per minute, representing only 7½ per cent of the safe maximum capacity of the average ⅝-in. meter. Of course, in dealing with domestic consumption, we must assume perhaps not more than 12 hours to constitute a day, which doubles the above figures. Still we find 93 per cent of the capacity to spare.

We must make further deductions. Allowing for the period when the greatest demands are made upon the service, 20 gal. per minute safely delivered by a ⅝-in. meter will certainly supply every need of the 6 families satisfactorily. If by coincidence, all families require water to be drawn simultaneously, nothing more serious would take place than a momentary slacking of the flow, which in all probability would never be complained of.

The writer lives in a 6-family apartment, and has lived there before and after a meter was installed on the service and has had an excellent opportunity to observe its effect. There are a total of 33 persons in the house in question, and with a ⅝-in. meter on the service, I have been unable to make any appreciable difference in the supply, nor have I heard a single complaint of poor service. As a matter of fact, I cannot recall that we have ever had a complaint of poor service to a 6-family house where the meter was found to be at fault, and we serve a great number of such houses, all through ⅝-in. meters. It will be appreciated that with the ⅝-in. meter performing as described, the other sizes mentioned work out in proportion.

When flushometer toilets are involved, we will not guarantee efficient service through a ⅝-in. meter, nor will we install a larger size, but recommend an elevated tank to supply them from which all the volume necessary can be had.

In metering commercial services, we endeavor to install the smallest size of meter that will properly take care of the consumption, and where large volume is desired only periodically, such as dye houses, we call upon the consumer to install a tank to serve the purpose.

For new supplies, practically all necessary information to determine the size of the meter to be set is furnished on a "Service Pipe and Meter Application Card." Meters are frequently changed in size to meet new conditions, and thus the sizes are kept well regulated.

Experiences of Spring Valley Water Co., San Francisco

By G. A. Elliott, Chief Engineer.

It is difficult to lay down a hard and fast rule covering the proper size of meters for any service. The quantity and rate of use of water in any premises depends, of course, upon several factors such as the character and number of the inhabitants, the number and kind of plumbing fixtures, the pressure, whether or not the supply is passed through a tank on the roof before reaching the house outlets, etc.

It is almost axiomatic that the smallest possible meter should be used that is consistent with the demand of the service, not only to secure economy in first cost, but in order to measure the flow due to small leaks. Where the rate bill carries a service charge or a minimum charge based upon the size of the meter, the retention of the good-will of the consumer demands that a small meter be used.

Since the metering of all domestic consumers in San Francisco, which was completed in 1918, a somewhat arbitrary rule has been used to determine the size of meter to be used on new services. It is based upon the assumption that under average conditions the entire use of water takes place in a total time of not over 2 hours in the 24; that a ⅝-in. meter will deliver without excessive loss of head, 8 or 9 gal. a minute, amounting to, roughly, 1,000 gal. in two hours, or 30,000 gal. a month, and finally that a 6-family house as a general rule will not use over this quantity. Carrying out this scheme, meters have been set as follows:

Size of Meter In.	No. Families.	Estimated Monthly Use, cu. ft.
⅝	1-6	4,000
¾	7-10	7,000
1	11-18	12,000
1½	19-26	24,000
2	27-50	40,000

Although this arbitrary rule has apparently been satisfactory in that no unusual meter repairs have been necessary, it has been felt for some time that the quantity limit and hence the family limit could profitably be increased for the various meter sizes.

A study of house uses was made with reference to the size of meter, which indicated that the existing rule could be modified. It was found in one case that 12,000 cu. ft. per month, or three times the arbitrary limit, was being successfully passed through a ⅝-in. meter, and that many instances existed where 6,000 cu. ft. monthly was measured by a meter of this size.

An interesting feature of the work appeared in the fact that there seemed to be no close relation between the number of families supplied and the quantity of water used. For instance, it was found that 6-family houses used from 2,800 cu. ft. to 6,100 cu. ft. monthly. At least one apartment house containing 22 apartments, all in use, was consuming only 4,500 cu. ft. per month, or less than was used by the 6-family residences. The tabulation following may be of interest in indicating the practical difficulties or predetermining the size of meter based on any rule involving the number of families served.

Size of House (No. Families)	Maximum Monthly Use, cu. ft.	Minimum Monthly Use, cu. ft.
2	3,600	400
4	6,400	1,200
6	6,100	2,800
8	6,600	2,900
12	19,000	4,500
16	18,900	4,900
20-25	23,700	12,500
26-35	24,900	7,300
36-45	34,900	15,500

Reference was made to the effect of the character of plumbing fixtures in fixing the size of meter, having in mind that certain outlets require a comparatively large flow when in use. The flushmeter toilet for instance, which through the elimination of the tank requires a large service and meter, under ordinary pressure conditions.

Many residences and small apartments are equipped with hose reels for fire protection, and these require large meters. On the other hand, a number of the larger apartment houses are equipped with storage tanks through which the entire supply is passed. In cases of this kind, a small meter operating over a longer part of the day than the use period will be ample for needs. An example of this class which occurs to the writer at the moment is illustrated by an apartment house containing 41 families which used 24,000 cu. ft. in one month through a ⅝-in. meter. It is of interest to note that of a total of 50,968 meters measuring the supply to purely domestic consumers in San Francisco, 50,864 are five-eighths.

It is the writer's present opinion that, with pressures of say 42 lb. on the average, the following tabulation can be followed in selecting meters for use in multiple-family houses, subject always to any known eccentricities in plumbing fixtures, or other features of the house requiring special arrangements.

Families.	Size Meter, ins.
1-9	⅝
10-14	¾
15-24	1
25-40	1½

Thirty-Five Miles of Sewers to Be Laid at Akron, O.—The city of Akron, O., proposes the construction of 35 miles of sewers between July 1 and the end of the year. The cost is estimated at $1,303,000.

Commercial Aspects of Water Storage for Power Purposes*

By E. B. WALTHALL

Assistant General Manager San Joaquin Light and Power Corporation

Storage may be classified under three different heads, which in the order of their commercial importance are:

First, Seasonal Storage—This is water that is regularly impounded yearly during the seasons of high runoff and abundant steam flow and released during the low water seasons of the year.

Second, Cyclic Storage—This is water impounded periodically during those years of abnormal precipitation and runoff and that is retained at some length and released during the low water seasons of abnormally dry years. It is usually difficult to find sufficient storage capacity in connection with any development to allow for the full seasonal storage requirements. Where extra capacity is available the problem of whether or not it should be developed depends upon the relative cost of steam and storage per annum, considering the frequency, length and severity of periods of drouth to be expected.

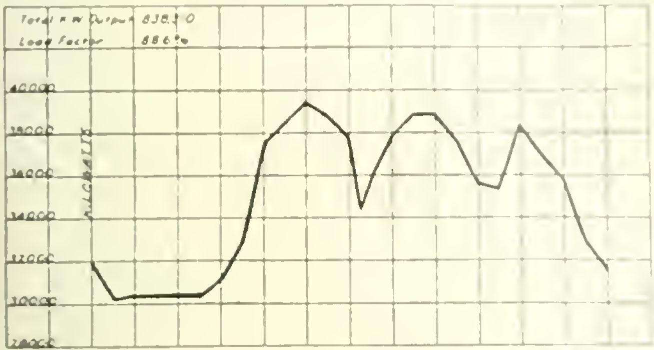


Fig. 1—Typical Daily Load Curve of Utility Having Combined Lighting, Industrial Power and Irrigation Pumping Load.

Third, Fluctuating Storage—This is water impounded daily, usually in comparatively small reservoirs or forebays during the hours of low load on the generating plant and released during the peak load.

Seasonal and cyclic storage may be created and have for its purpose the generation of electricity exclusively, or it may be created primarily for the irrigation of lands and incidentally the generation of electricity as a by product.

The storage of water primarily for irrigation purposes and the generation of electricity as a by-product may be located almost without regard for elevation but with every regard for drainage area and its attendant runoff. However, the storage of water for power purposes must be carefully and accurately located by an extensive investigation and every consideration given to both elevation and runoff.

Storage at extremely low levels results in a small available head and low kilowatt-hour value per acre-foot of water stored when compared with the cost of creating that storage. Storage at extremely high levels results in a large available head and a high kilowatt-hour value per acre-foot of water stored, but usually the drainage area controlled and the water supply is so limited and restricted as to not warrant the expense of creating the storage. However, at some point between the two extremes there will be found storage that can be economically developed and which will have a satisfactory head, together with a drainage tributary to it that will furnish a suitable and adequate supply of water.

Use of Fluctuating Storage for Combined Power and Irrigation Pumping Purposes. Figure 1, illustrative of the use of fluctuating storage, is a typical "Daily Load Curve" of a utility serving a combined lighting, industrial power and irrigation pumping load during the season when the irrigation pumping load reaches its highest point. This load is quite uniform throughout the 24-hour period, as in indicated by the resulting high load factor of 88.6 per cent. Most of the power companies, however, experience a much greater and more sudden variation in load conditions. It will be noticed that even with this load the daily fluctuation is a very large percentage of the peak load carried. These sudden variations in load must either be taken care of by a steam plant or storage must be provided at or very near the head of the hydro plant penstock.

The ideal condition for economy for high head plants with considerable length of conduit, would be to have an average ditch or uniform amount of water flowing at all times with sufficient storage in the forebay at the head of the penstock to take care of the daily fluctuations. This is not often possible, however, on account of the physical conditions surrounding the point at which the conduit line must be terminated and the penstock begun. Where the pressure conduit leads directly from a large storage reservoir, no additional fluctuating storage is necessary.

Theoretical considerations of economy will show that certain portions of the fluctuating load should be taken care of by steam on any system. The curve of "Duration of Load," Fig. 2, shows that only a very few kilowatt hours are turned out at the highest load. As steam plants cost less per kilowatt of installation than hydro plants, steam capacity should be installed down to the point where the annual cost per kilowatt of steam fixed charges, plus operating expense and fuel, is just equal to the fixed charges and operating expenses per kilowatt of hydro capacity.

How to Get Best Results from Use of Seasonable Storage.—Figure 3, illustrative of the use of seasonal storage, shows a curve of typical natural stream flow output and one of a typical load crossing at the end of the high runoff season. Both curves are expressed in average monthly kilowatts, that is, the kilowatt-hour output for the month divided by the number of hours in the month. The area between the curves after crossing represents the kilowatt-hours which must come from storage or from steam.

The maximum peaks for the month are shown in the upper curve of the chart. The maximum distance between the line indicating the hydro output from natural flow, and the peak load line represents the minimum steam capacity needed if no storage is provided. Reserves of steam capacity above this theoretical minimum must be provided if continuous service is to be assured, but even a comparatively small storage will eliminate the necessity for installing this additional steam reserve, as stored water may be used while the steam plants are shut down for repairs.

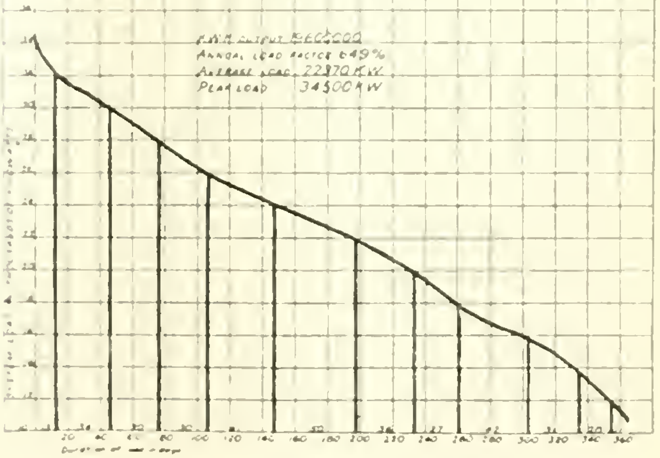


Fig. 2—Duration of Load Curve.

In general it may be said that seasonal storage is necessary to the full economic usefulness of high head mountain plants and that if sites are available, storage should be provided so long as the average cost per unit of output from storage, including fixed charges on the investment, is less than the average output cost from steam.

The rates of any electric utility must yield sufficient income to pay all operating expenses, including the fixed charges such as interest and depreciation on the investment. The investment in storage reservoirs and the cost of operating them has a very decided bearing on the rates which the company should charge. By the installation of storage the companies operating in regions where high head plants are installed on comparatively small streams with considerable fluctuation in runoff, will be able to carry very much greater loads throughout the year than would be the case if storage were not available.

Charges for Storage.—In the case of the typical annual curve of load and output from natural stream flow, the utility is able to take care of the load during the latter part of the year by using water from storage reservoirs now provided. This means that it can carry practically twice the load with its installation that it could carry if no storage were provided. Of course, if no storage were provided, it would not be economy to install hydroelectric equipment much above the low water capacity of the stream. The cost of interest, depreciation, etc., on storage reservoirs must be distributed over the income to be received from all consumers, although many may not directly benefit from it, for the reason that their load is taken up by the base water powers or comes at seasons when the storage is not being used.

---

*Abstract of a paper presented last May at the annual convention of the National Electric Light Association.

In figuring rates on the cost of service basis, the costs are usually pro-rated among classes of consumers on the basis of the demand of the class on the system, kilowatt-hour consumption of the class, and the number of consumers in the class. This raises the point of whether or not the fixed charges on investment in storage are demand costs or should be proportioned in accordance with the amount of energy used. There are logical arguments for both.

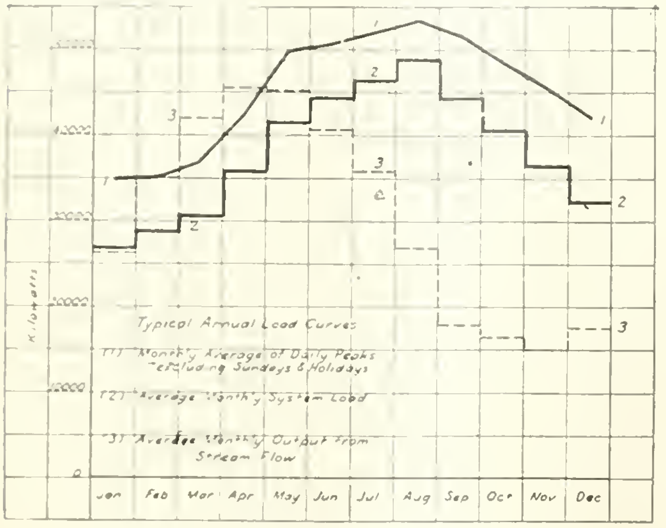


Fig. 3—Illustration of Use of Seasonal Storage.

Most utilities operating plants backed by storage would not be able to carry the load they do carry throughout the year without the storage which has been provided. Hence it may be said that the charges for storage should be proportioned to the demand on the system. On the other hand, the company having a low load factor and a comparatively high demand, would be able to operate throughout the year with much less storage than a company which had a very high load factor. Either basis might be used and the conditions of the case under investigation should determine which is to be used.

Advantages of Large Fluctuating Storage Capacity.—A hydroelectric development with a large fluctuating storage capacity is in a position to carry its load through considerable periods of time without a supply of water being brought to the power plant, hence it may be possible to carry the load right through such interruptions as those due to breaks in ditches, flumes, etc. The water available at the head of the penstock enables the plant to take the fluctuations in load without in any way endangering the penstock.

A hydroelectric development with a considerable storage of water available can feel fairly sure of its ability to carry its load through the low water season of the year, and can reasonably assure its consumers practically continuous service, barring interruptions due to line and other electrical troubles which do not depend upon the water supply.

It will generally be found necessary, however, to install steam capacity as a reserve in connection with the operation of any hydroelectric development if its load approaches its capacity, in order to be in a position to give service of the reliability now generally demanded.

It is customary to locate these plants at or near centers of distribution so that they may be between the usual transmission line troubles and the point where the energy is to be used. If the steam plant is located in a different part of the system from the hydroelectric plant, it is also possible to give service over a great part of the system when lines are interrupted near the hydroelectric power house. It may be economy to install steam capacity to carry a portion of the load which might be carried by storage where the storage sites cannot be developed at or nearly at normal cost.

The Quebec System of Long Distance Laboratory Control of Water Supplies

For the past two years the Quebec Provincial Board of Health has been using a system of "long distance" laboratory control of water supply. Under this scheme daily shipments of samples of water were sent by mail to the laboratory of the board for the determination of the presence of B. Coli. The plan was described by Mr. Mac H. McCrady, Chemist and Bacteriologist of the Board of Health, in a paper presented at the recent convention of the American Waterworks Association. An abstract of the paper follows:

Method of Sampling and Mailing Water.—Lots of 20 or 30 small mailing cases are shipped by the laboratory to the town for which the water supply is to be examined. Each mailing case contains 4 cork-stoppered glass tubes, graduated at 7 c.c., and containing 2 c.c. of concentrated medium. Every day the 4 tubes of one case are filled to the mark by the sample collector with the water to be tested, each tube thus containing 5 c.c. of sample, and the case is mailed to the laboratory. At the laboratory a small inverted vial is placed in each tube, the tube tipped in order to fill this vial, and the whole then incubated at 37 C. in the usual manner, results being noted after 24 and 48 hours' incubation. Further identification, in case of positive results, may be practiced if required.

Advantages of the Method.—The following features of this mailing method are worth noting: (a) The outfits are inexpensive, for the cases, tubes, vials, etc., are all of standard size, and are readily prepared for use by laboratory assistants. (b) Time of transit is reduced to a minimum, for the excellent service of the mails is utilized. (c) Cost of shipment is extremely small, for the case goes through the mail for the insignificant postage cost of 3 ct., under the classification of "sample." (d) The very little labor entailed in collection of samples ensures a surprising regularity in such collection, and renders it possible to enlist the services of any physician or municipal officer for this purpose. (e) Check samples from the same town may be multiplied. (f) At the laboratory a large number of cases may be received each day for they may be handled at the rate of about one per minute. (g) A day is often gained in obtaining results by this method as compared with ordinary bottle samples, for, because of multiplication of the organisms during transit, ultimately positive tubes are usually positive after one day of incubation. (h) Each day's result is quantitive, for the case contains four samples of 5 c.c. each, and the total of 20 c.c. permits a fairly complete test for B. coli. (i) Breakage in the mails is an insignificant item, and even when, as has happened once or twice in our experience, four tubes were broken, there was no evidence of leakage or stain on the outside of the case, for the liquid is readily absorbed by the paper packing. (j) Overgrowth of B. coli by other organisms in transit does not appear to be an important factor. Occasionally we have received a case which had been held four or five days, and yet fermentation of an apparently normal character proceeded upon incubation.

So far as we have been able to judge from many control bottle samples and from two or three more extensive comparisons in the laboratory, this mailing method appears to be quite trustworthy, and although results from it may not be so satisfactory or complete as those obtained from bottle samples collected in the usual manner, its inexpensiveness and general applicability have demonstrated its utility.

In the province of Quebec this system of sampling has been employed for a variety of purposes, but particularly in long-distance control of purification plants it has been of the greatest service. It is the practice to post, every day, in the chart in the office of the sanitary engineer who is charged with the supervision of these plants, the results obtained. Possession of such a daily record permits concentration of attention on those plants which are really in need of improvement, and in the case of isolated unsatisfactory results, a telephone communication followed, if necessary, by a personal visit to the plant in question, serves not only to frequently discover failures in the mechanical equipment, but also to maintain a lively interest on the part of the operator, an interest further stimulated by receipt of a weekly statement of the results obtained.

To date, the laboratory for the Province has examined over 18,000 tubes of water sent through the mails. These samples have, in the main, come from [illegible] or 20 different purification plants. Now that further supplies of mailing cases are obtainable, it is intended to extend this service to other plants in the province.

Two years of experience with the method of sampling and analysis have proved it to be extremely simple and practicable, and the writer believes that it supplements, effectively and satisfactorily, the more infrequent examination of the bottle samples usually employed for long-distance bacteriological control of water supplies.

Equipment and Manipulation.—The mailing case is a metal can, lined with paper board, with screw top, O. D. 2¼ in., length 3¾ in., supplied by Improved Mailing Case Co., of New York; extra paper inserts in cover and bottom to absorb liquid in case of breakage; partition of double-faced corrugated straw-board to divide the can into four compartments. The paper-box manufacturer who supplies the board cuts it into rectangles 2x3½ in., and laboratory assistants cut and fit the rectangles to make the partitions. Can and covers are sterilized before use by dry heat in the usual manner.

The specimen tubes (shell-vials) are flat bottom, straight wall, O. D. ⅝ in., length 2⅞ in., are graduated with a mark at 7 c.c. This is done with a pipette, the meniscus is marked with a wax pencil, and with a small file wet with water, a cut of about ¼ in. in length is made in the glass at the pencil mark. The tube will not break at this mark upon sterilization.

The concentrated medium may be any that the laboratory may elect, but so constituted that the 2 c.c. of it when added to 5 c.c. of water sample, will give the required concentration of mix.

The tubes are placed in a zinc rack holding about 48 tubes, and 2 c.c. of the concentrated medium is placed, by means of a pipette, into each tube. First-class cork stoppers are then fitted into the tubes, rather loosely to avoid their blowing out upon sterilization. Corks are of the long form, which when thrust home, will project about ⅔ in. beyond the tube. A deep zinc box cover is then placed over the rack to keep by its weight, the corks in the tubes, and to protect the tubes from undue contamination. The whole is then sterilized in the autoclave.

After sterilization, the cover being removed, each cork is firmly thrust into its tube, and the tube placed into its compartment in the mailing case. When the case contains its four tubes, the cover is screwed on, and the label affixed to the body of the case. This label is printed with the address of the laboratory, the word "Sample" to place it in the proper postal classification, and the word "Date," after which the sample collector is to write the date of collection of samples.

When shipping a lot of cases to a town, a number or group of letters for that town is stamped on the label in order to identify the case upon its return to the laboratory.

The sample-collector, with the usual precautions, fills each of the four tubes of a case with water to the mark on the tube, writes the date of sampling on the label, and affixes a 3-ct. stamp.

The case is identified at the laboratory by the number or group of letters on the label, and the date of collection and of receipt noted on the record sheet. Each tube is removed from the case, its cork stopper withdrawn, and a small vial or specimen tube, O. D. ¼ in., length 2 in., is inserted, inverted, into the tube. These vials are contained in a beaker, covered with a Petri dish, the whole having been previously sterilized. The vials are taken from the beaker with flamed tweezers. The cork is then replaced, the tube tipped so that the small vial is filled with the liquid in the tube, and the tube then placed in a wooden rack, which consists of a block 12 by 3 by 1 in. thick, containing four groups of four holes each. The four tubes from the case go into the holes of one of these groups, and the day of collection and day of receipt are written in pencil on the wood near this group of tubes. Each town from which samples are received has its own rack, permanently marked. The rack is then placed in the 37° C. incubator.

Results are read after 24 hours, and again after 48 hours. At least 10 per cent of gas is required for a positive result, as it is difficult to remove every last small bubble from the vial when the latter is inverted into the tube.

The record form used by the laboratory is the following:

[illegible]

Sherbrooke [illegible]
1 2 1 2 [illegible] 0 0
2 4 0 0 [illegible] 1 1

From the above record, a case received from Sherbrooke on June 2, samples having been collected on June 1, had 1 tube positive after 24 hours' incubation, and 2 tubes positive after 48 hours' incubation. Case sent on June 2, and received June 4, had no tubes positive after either 24 or 48 hours' incubation.

The range of numbers of B. coli corresponding to results obtained with four, three, etc., tubes of 5 c.c. of sample each, is shown below (as probable numbers of B. coli):

4 tubes.

Positives.	B. coli per 100 c.c.
0 4	0
1 4	6
2 4	14
3 4	28
4 4	32 considered as a 4 5 result, at least.

3 tubes.

Positives.	B. coli per 100 c.c.
0 3	0
1 3	8
2 3	22
3 3	28 considered as a 3 4 result, at least.

2 tubes.

Positives.	B. coli per 100 c.c.
0 2	0
1 2	14
2 2	22

1 tube.

Positives.	B. coli per 100 c.c.
0 1	0
1 1	11

Reducing Waste of Water by Railways

It is estimated that the railroads of the United States use 900,000,000,000 gal. of water per year, one-fourth of which is purchased from private or municipal water plants, and which undoubtedly represents no inconsiderable portion of the water purchased by these plants. It has been estimated that 20 per cent of the water used by the railroads is wasted. If this estimate is correct we have 180,000,000,000 gal. of water pumped per year for no purpose other than to increase the expense of railroad operation and burden the pumping plants with an additional load. Using the figure of 25 lb. of coal for each 1,000 gal. of water pumped, the waste requires the consumption of 2,250,000 tons of coal, or more than 6,000 tons per day, and no doubt the part that this waste plays in the expense for additions to power and pumping equipment would, in comparison, make the coal bill look insignificant. The above figures from a paper by C. R. Knowles, Superintendent of Water Service for the Illinois Central R. R., presented at the National Convention of the American Waterworks Association indicate the importance of the railroad water waste problem. In his paper, an abstract of which follows, Mr. Knowles, describes the various measures taken by the railroads for preventing this waste.

The duties of a city water works manager and the duties of a superintendent of railway water service are parallel. They concern the economical production of water adequate in quantity and satisfactory in quality. There is the difference, however, that the manager of the private or municipal water works is in constant touch with his plant or plants and has direct supervision of their operation, while the plants on a railway system may be scattered over half a continent, and are subject to the varying conditions peculiar to the territory in which they may be located. Consequently, some of the problems encountered in the prevention of water waste on railroads may be novel to the city water works man.

Water Waste Campaign of Illinois Central R. R.—The writer has been conducting a water waste campaign on the Illinois Central R. R. system for the past 5 years, endeavoring to impress upon officers and employes the value of water and the importance of water waste prevention. It is very gratifying to be able to report that this campaign has resulted in a material reduction in the waste and unnecessary use of water.

The total consumption of water on the Illinois Central system for the past 5 years, divided between water pumped by company forces and water obtained from an outside supply is shown on the following table:

	Company plants Gal.	Outside supply Gal.	Total Gal.
1915	15,300,000,000	2,986,000,000	18,286,000,000
1916	15,140,000,000	2,844,000,000	17,984,000,000
1917	14,000,000,000	2,754,000,000	16,754,000,000
1918	14,140,247,000	2,771,674,000	16,911,921,000
1919	12,967,260,000	2,655,740,000	15,622,000,000

It will be noted that the consumption in 1919 was 2,661,000,000 gal. less than 1915, while the average reduction for the 5-year period is 1,468,019,750 gal. During the above-mentioned period there was an increase of over 20 per cent in tonnage handled, which would indicate that a still greater reduction was made in the waste of water than is shown by the above table.

The reduction in waste of water was accomplished by frequent water surveys at all points on the system, varying from an investigation of a single hydrant at an outlying station requiring only 10 or 15 minutes' time to an investigation of the water supply at large terminals, sometimes requiring several days.

Waste of Water in Filling Locomotive Tanks.

At a large southern terminal, a request had been made for authority to expend approximately $20,000 for new pumps and pipe lines, the request being based upon the assumption that the old pumps and pipe lines were too small to furnish sufficient water. A water waste survey disclosed the fact that 40 per cent of the water pumped was being wasted. When these conditions were corrected there was no difficulty in providing all the water required without any expenditure for additional equipment.

How Water Consumption in Office Building Was Reduced. The consumption of water at a large office building used for general railway purposes, had increased to approximately 8,000,000 gal. per month, and as this consumption appeared excessive, a water waste survey was made, with the result that the consumption was cut to approximately 2,000,000 gal. per month, a decrease of 75 per cent. The conditions at this point were due to general waste of water through almost every water facility in the building. For example, the controlling valves on the boiler feed water heater were not operating properly, allowing unlimited quantities of water to pass through the heater to the bilge tanks where it was being pumped by an electric bilge pump to the sewer, this waste causing three distinct losses.

1. The cost of furnishing the water;
2. The loss of the coal required to heat the water which at the time the investigation was made was estimated to be the equivalent of 250 B.H.P.;
3. An additional loss of electric current required to pump the water from the basement level to the city sewer, the bilge pump operating every 30 seconds at the time the investigation was made.

The urinal tanks, 18 in number, were found to be flushing at intervals of from 30 seconds to 1 minute and 10 seconds. These tanks were of the 3-gal. flush type, probably 2,000,000 gal. of the water being used through these urinals. The controlling valves to the house tanks were in bad order, and the overflow from these tanks to the sewer was practically constant. In addition to these large wastes there were a number of minor wastes of hot and cold water in the restaurant and other places in the building.

Waste Prevention at Engine Terminal.—At a large engine terminal in the Middle West, the automatic valves controlling the water supplied to a large hot water boiler washing system were found inoperative, the consumption of water through the boiler washing system amounting to 300,000 gal. per day. Upon repairing and adjusting the valves, the consumption decreased immediately, and the daily consumption at the present time is approximately 60,000 gal., a saving of 80 per cent of the water formerly used.

At another point, the consumption was decreased nearly 3,000,000 gal. per month by adjusting and repairing automatic valves controlling water supplied to a boiler feed water heater and boiler washing system. In this particular instance, the saving in heat applied to the water wasted was in excess of the cost of the water.

Numberless other instances could be cited where material economies in the use of water have been effected through these water waste surveys, those quoted above being merely given as examples. The favorable results of our efforts towards prevention of water waste have not been easily obtained, as it is extremely difficult to convince the average railroad employe that he should exercise care in the use of water, since he cannot understand why one should worry about water with innumerable lakes and rivers on and adjoining the right-of-way. He cannot appreciate the fact that costly pumping stations, reservoirs, water softening plants, storage tanks and pipe lines are necessary to deliver the water to the point of use.

Why Waterworks Operator Should Be Interested in Preventing Waste Where System Is Metered.—I have been asked why the city water works manager should be interested in water-waste prevention where the water was supplied through meter, and the cost of such waste billed against the consumer?

In the first place, it is to the interests of all public officers to prevent waste in any form as their interests are not limited to the individual, but to the community as a whole. They recognize it as their duty to lead in campaigns for the elimination of waste in all forms, as the creation of waste benefits no one and adds nothing to the wealth of the country, institution or the individual. The city water works manager realizing his duty to the public good in his efforts to eliminate waste does not stop to question whether the waste goes to make a part of his revenue or not. While there may be some instances where a waste of water would increase the revenue of the water company without materially affecting the operation of the plant, unlicensed waste on the part of one consumer jeopardizes the supply to others, and, injustice to all, waste cannot be tolerated whether the waster pays for it or not. The water company cannot afford to encourage water waste, even by metered consumers on account of the example set to those who are not metered, and have no interest in keeping down the consumption. Excessive waste such as might occur with a large consumer such as a railroad company causes a great fluctuation in the demand. While 1,000,000 gal. a day, more or less, would make but little difference with a plant pumping 100,000,000 gal. or so per day, it would create a serious condition with many smaller plants, and, doubtless, in many places the correction of waste and unnecessary consumption would eliminate the necessity of expenditures and additional pumping equipment and distribution system—a serious matter under present material and labor conditions.

Water Waste in Coach Yard.

The heavy migration to the cities in recent years has increased the urban population and the demand for water for domestic purposes to such an extent, that many water plants are facing expenditures for additional capacity at a time when it is extremely expensive and difficult to make such extension. The reduction of waste will undoubtedly postpone these extensions until conditions return more nearly to normal.

A writer in "Engineering and Contracting" calls attention to the enormous waste of water by one of the largest cities in the world and goes to show that the prevention of waste through installing meters at a cost of $[illegible] would save an investment of $44,000,000 for additional equipment not to mention a saving of $69,000,000 in annual wages and repairs.

As the equipment and appliances used in modern water works have increased in cost 50 to 100 per cent there is no question that many water works plants are overworking their power houses to supply water to be wasted and that many requests for appropriations are the direct result of waste beyond the control of the water works manager.

Many of the cities supply water at sliding rates giving the large long-hour consumer the benefit of the low rates. As the railways are large consumers, the water which they waste is nearly all furnished at the lowest rate, rates yielding a comparatively small net profit to the water works company. If this water were made available for distribution to a large number of small consumers the net revenue would be increased materially, thus benefiting both the railroad and the water company.

The Grouting of Wells in Rock Formations

By W. G. KIRCHOFFER

Sanitary and Hydraulic Engineer, Madison, Wis.

The wells discussed here are those that are drilled and receive their water from a rock formation, and may be either deep or shallow. The reasons for grouting wells in the manner hereafter described are:

First—To save the head of the flowing wells by preventing leakage into non-water bearing strata or through openings in the casing made by rust.

Second—To protect the casing of either non-flowing or flowing wells from decay by substituting a cement mortar casing.

Third—To prevent the water from becoming polluted by seepage from a source of contamination near the surface, which perhaps is the most important of all and warrants the extra expense incurred.

Fourth—Cheaper casings can be used as they are put in only to support the loose materials above the rock and as an exterior form until the grout is set.

This process can be used on either new or old wells. If the old well is small in diameter and the surface of the rock or other non-caving formation is near the surface, the well can be reamed to a size sufficient to allow for the grout or the size of the well may be reduced by inserting a smaller casing properly packed at the bottom to provide a form for the cement mortar.

When a new well is to be specified, that portion of the well that must be grouted is drilled to a large diameter, say 15 in. to 20 in., and to a depth sufficient to prevent leakage, seepage, etc. The depth to be grouted is usually predetermined by a knowledge of the strata and should best be at or near the top of the water bearing formation from which it is desired to secure the water. An outside casing must be used where materials will not stand long enough to complete the work.

The size of the hole at the bottom of the grout should be reduced to just large enough to receive the "liner," which should be seated firmly in the rock to a depth of at least 2 ft. The liner can be made of any grade metal sufficiently strong to withstand handling and prevent collapse. The top of both outside and inside casing should reach the surface of the ground or to the point where the water is to be taken. In the case of flowing wells, the liner may be used as the discharge, or suction pipe if pumped, and directly connected to the pump or horizontal pipe. A space between the two casing should be at least 2 in., but more is preferable.

The grouting apparatus consists of a line of 1¼ in. pipe sufficient to reach within a few feet of the bottom of the space to be grouted. A hand or tank pump and a light barrel or watertight box of about the same size. The 1¼ in. pipe is hung between the liner and the outside of the well and so connected that it can be readily raised as the filling progresses. The cement grout is made of such consistency so that it will pour readily. No sand is added while the pump is in use.

The dosing box or barrel is placed above the pump, thus the suction lift is eliminated and for that reason the grout flows much more readily. The water in the well should not be disturbed during grouting as any difference in pressure might cause the grout to flow out of the annular space between the casings into the well. Tests for this leakage should be made by means of a small bucket which can be made of ¾ in. pipe, 6 in. long, let down in the well opposite the end of the liner. If cement is getting into the well, the water will have a milky appearance when brought to the surface.

When the grouting has reached a point near enough the surface so that all rock crevices are surely covered, the grouting may consist of one-third sand and two-thirds cement. This is then poured in place or pumped into the pipe.

At Whitewater, Wis., the water works plant has two deep wells, No. 1, 976 ft. deep and No. 2, 510 ft. deep; also two shallow wells. The 976-ft. well was drilled many years ago and when completed had a head of 1[illegible] ft. above the ground level. It then flowed 218 gal. per minute into a reservoir 110 ft. in diameter. The flow gradually decreased until it, with the two shallow wells, flowed only 1 in. in depth into the reservoir in 12 hours. The 510-ft. well was located close to Whitewater Creek, which receives the drainage from the city. The rock formation came near the surface at this point and was very badly shattered.

After the sewerage system was constructed and before the disposal plant was completed, No. 2 well became contaminated to a marked degree. The surface of the St. Peters sandstone, from which a portion of the flow was obtained, was encountered at a depth of about 154 ft. Plans and specifications were drawn for the reaming and grouting of these two wells to a depth of 156 ft. The outside casing in the surface materials was 16 in. O. D. casing and the hole in rock was 15 in. in diameter. The liner used was 8 in. inside diameter. The holes below a depth of 156 ft. were reamed to 8 in.

When the work on the No. 1 well was completed it was again connected to the reservoir and the combined flow of it and the two small wells was found to be 6 in. in depth in 12 hours in place of 1 in. before grouting, an increase of 500 per cent. Well No. 2 was not connected to the reservoir so no measurements were made, but contamination ceased. This well was really a new one, as the rock in the old well was badly shattered and the hole crooked, so that it was not reamed like well No. 1. This will be reduced to 4 in. in diameter (is now 8 in.) and will be grouted like the other.

A lump sum contract was awarded to the W. L. Thorn Co. of Platteville, Wis., for the work down to a depth of 156 ft. for the sum of $2,350. The reaming below that depth was $3.50 per foot. The greater part of the cost of the work was, of course, in the reaming to a diameter of 15 in. and the casings. The process of grouting after the equipment is on hand is very simple and comparatively inexpensive.

The work of grouting well No. 1 was performed in two days by three men, 27 barrels of cement being used in the work.

At Mineral Point, Wis., two wells about 150 ft. deep were supplying the city, but became contaminated by surface water from the hills nearby. A new well of the same diameter as those at Whitewater was put down to a depth of 150 ft. and grouted to a depth of 61 ft. This well cost $710. The detailed prices were: In surface formations requiring 8-in. and 15-in. casings with grouting, $10 per foot. In rock requiring only 8-in. casing and grouting, $7 per foot. 8-in. hole in rock, no casing or grouting, $3 per foot.

To show a comparison of the bids on work of this kind with work involving only one casing, the following bids were received: At Sparta, Wis., for drilling and casing a 16-in. O. D. hole to depth of 117 ft. with 10-in. liner and grouting to a depth of 160 ft., $1,850 was the lowest bid. For the same hole 10 in. in diameter cased to 117 ft. without grouting, the lowest bid was $899.

At Hartford, Wis., where it was advisable to grout the well to a depth of 320 ft. the lowest bid on this work was as follows:

130 ft. cased with 16 in. O. D. casing, 330 ft. 10 in. casing and grouted to a depth of 330 ft. for the lump sum of..	$3,180.00
300 ft. 10 in. hole in rock at $5.00	1,500.00
Total	$4,680.00

Wells completed by this method are necessarily more expensive than the old method of "casing to rock" and a "hole in rock" regardless of the nature of the rock or its water resources or danger to health through possible sources of contamination; but they do have some or all of the advantages as set forth at the beginning of this article.

How the Seattle Plan for Prevention of Labor Troubles Has Worked

By F. R. SINGLETON.

Seattle today is practically a strikeless city.

Several months ago the story of how the Associated Industries of Seattle had broken the domination of radicals over the industries of that city, by a firm and successful stand for the open shop, was published broadcast throughout the United States. The employers of Seattle, banded together in the Associated Industries, declared their independence of restrictive union rule; stood for their right to hire their own men and the right of the employes to work, regardless of membership or lack of membership in a union; and established those rights by defeating a series of strikes to enforce unreasonable demands.

Back of this stand of the united employers of Seattle was the knowledge that the radical labor leaders had planned to practically take over the industries of Seattle and operate them, ostensibly in the interest of organized labor. Accordingly it was a fight for the perpetuation of industrial freedom in Seattle in which the whole United States was interested.

The story of the methods followed by the Associated Industries in defeating strikes and establishing the open shop; of the broadsides and other publicity in the daily newspapers to win public sentiment over to the "American Plan" of industry; of other phases of the struggle in which employers stood steadfast with unbroken ranks in the face of efforts to close their plants, was read with sympathetic interest by employers throughout the United States, and the Seattle plan of open shop campaign has been adopted in several notable instances since that time.

Naturally, the question has arisen in many minds: Will the Seattle plan endure? Will results be permanent and justify the struggle and expense entailed in putting it over?

Events of the past six months in Seattle justify answering this question in the affirmative. While many sections of this country are still troubled with destructive strikes and interference with production, Seattle today is free from strikes, harmony between employes and employers is on the increase, and the open shop has been established in every industry in which a strike has occurred.

When the story of Seattle's struggle to throw off the radical yoke was published, strikes in the building trades, the cleaning and dyeing and some minor industries, had been won and the community thoroughly converted to the open shop idea, but several other strikes were still in progress, leaving the ultimate outcome in doubt. Since that time the employers have won out against the printers, one of the oldest and most powerful unions in Seattle; against the tailors and several other unions which saw fit to strike. Since August, 1919, every strike has been won completely by the employers and the open shop substituted for radical union domination.

Following a winter of comparative peace radical union leadership attempted to force the issue again in the spring, in the hope of breaking the open shop movement. Attempts to force a new agreement with burdensome conditions on the baking industry late in April resulted in an open shop declaration by the master bakers, and a new strike which the employers won in short order. An abortive attempt was made to call out the workers in the building trades on May 1, which amounted to nothing, for the building trades workers had their fill of strike last year. The defeat of the building trades strike, which lasted from August to November, 1919, was the first important victory of the Associated industries and the occasion of the first open shop declaration. Since that victory, things have progressed in the building trades, accompanied by increased production. The majority of the union workers had accepted open shop conditons. They did not wish to go through another period of enforced idleness and so the efforts of union leaders to bring on another strike and overthrow the open shop were fruitless.

The most striking example of Seattle's freedom from the old-time radical domination, however, occurred on the Seattle water front. During the war, the local of the International Longshoremen's Association got a stranglehold on water front employment. Employers had practically nothing to say about the hiring of men, gangs of longshoremen and truckers being furnished by the union from the union list at the union hall. Although Seattle is a busy port, the union contained about twice as many men as there was full employment for. As a result, the work was often stretched out sufficiently to give a satisfactory measure of employment to all and the cost of handling cargo became inordinately high. Last fall, the employers succeeded in reaching a new agreement which abolished the list system, but early in May the I. L. A. served peremptory notice on employers of the re-establishment of the list system, thereby breaking the clause of their agreement requiring 30 days' notice of termination.

There is a large radical element in the Seattle local of the I. L. A. In fact, it was regarded as one of the last strongholds of radicalism, and a test of strength had been postponed as long as practicable by the employers, but the course of the union left no alternative but to declare open shop and fight it out. That action was taken by the employers. A surprising number of men responded to advertisements of work under the open shop. Within two weeks, work reached normal on the Seattle water front, and the I. L. A. declared the strike off under orders from the international officers who had refused to sanction the strike. As a result, there is a surplus of 1,000 to 1,500 men on the water front who will eventually have to find other work, for the employers are giving practically continuous employment to those who helped them out during the strike, and who wish to remain at work. Also the conservative element of the union has broken away from the radical leadership and is applying for a charter for a new local.

Also, Seattle escaped any interruption of freight service. While railway workers were striking in many sections of the country, the railway workers and switchmen refused to go out, even in sympathy with the longshoremen.

The Associated Industries has just held its second annual election. In one year of work it has changed Seattle from a radical-ridden and strike-disturbed city to one of the most peaceful and productive cities, from the commercial and industrial standpoint, in the United States. The defeat of the radicals has driven some thousands of them from the city, and Seattle is no longer the stronghold of the I. W. W. and the hotbed of soviet conspiracy.

Yes, the Seattle plan has proved a success. The Associated Industries, after an eventful year, is stronger in membership, finance and influence than ever before. It has followed consistently the declaration of a square deal for the employes. In spite of the surplus of labor that has existed for several months with the decadence of the shipyards its members have lived up to their pledge that wages would not be reduced until living costs receded. In some instances wages have been increased without any requests being made by the employes.

Seattle union men are not discriminated against in the operation of the open shop. Instead, the employers simply refuse to deal with the unions as such. The shop committee system is being worked out to give employes the representation promised them under the open shop. The policy of the Associated Industries is to give the employes such representation and fair treatment that the union is unnecessary to them.

That is why Seattle today is a strikeless city

Experiences of a Waterworks Superintendent*

By BEEKMAN C. LITTLE

Superintendent Bureau of Water, Rochester, N. Y.

From many sources we are now learning that all over the country there is a great let up in new construction work. Anyone knows that every waterworks manager deserves a rest, but long years of experience have taught me that he never gets one, and that when possibly a chance like this one appears, then is the time for him to dig in and be busier than ever, for it gives him an opportunity to devote his attention to overhauling, repairing and bettering his whole plant.

Hydrants can be painted and repaired, stop valves relocated and tried out for operation, mains tested for leakage, pumps and engines gone over, and new efficiency figures and pump-slippage obtained. Meters can be removed for tests. It may be a good time to flush or, better yet, thoroughly clean out some of your mains. We have had excellent success with contractors who do this work. Often this cleaning of a main will delay for several years the apparent need of a larger pipe.

Don't neglect fire service connections. Whenever you have any time, look after these connections and the check valves on them. If the sprinkler or fire system is connected up with a secondary, contaminated, or even suspicious supply, my experience would prompt throwing away the check valves and cutting off the supply.

Contamination of Domestic Water from Auxiliary Fire System.—There are check valves which will work, and methods of inspection which prove the functioning of the valves, but no valve and no system of inspection will prevent the trying experience that we went through some years ago.

Very briefly stated the occurrence was as follows: A lift bridge over a canal in Rochester was so constructed as to be operated by either of two water systems: one, our domestic supply and the other our entirely separate auxiliary fire system of non-potable water. The two systems, however, were never intended to be turned on and into the operating house at once. The street gate on one system or the other was always shut, but as an additional precaution check valves on each system were installed.

Between inspections, however, an over-zealous, ignorant canal employe obtained secretly a gate wrench, closed the open street gate and then proceeded to unbolt the flanges on the check valves in the basement of the operating house and remove the checks or flaps entirely. He then bolted the flanges on again so the valves appeared to be in order and opened both street gates. The result was that contaminated water entered our domestic system and a number of typhoid cases followed. It is assumed that he imagined that a higher pressure would be the only result of his work. This system of ours had operated successfully for some 3[illegible] years, but it was not proof against deliberate tampering with the fixtures.

Modernizing the Accounting Department.—In looking over your plant don't overlook your accounting department. Investigation finds surprisingly few water bureaus using up-to-date methods in their book-keeping. In our cities you will find generally that the gas and electric corporations are the only ones having as many customers on their books as has the water company, and yet a great many of these smaller business and manufacturing concerns find that it pays to put in loose leaf ledgers, adding machines, billing machines, and a still more wonderful one, the bookkeeping or posting

A good many of us, I am afraid, especially in the municipally-owned plants, are going on in the same old way handed down to us from former city administrations, perhaps, dating back some 30 or 40 years. In Rochester up to a very short time ago, we were copying our accounts in longhand into some 70 immense ledgers, each one weighing on an average 50 lb. They were too bulky to put away at night, or even to be moved around much during business hours, so they lay all day on long desks taking up a great deal of room and of course much time was taken in going from one to the other to look up accounts.

We now have all of our [illegible] in 21 or 22 volumes, weighing about [illegible] lb. each. These are loose leaf ledgers with 16 or 1[illegible] accounts to a page, and the sheets are ruled to last a year. At the end of the year new sheets are inserted and the old ones removed from the binders and stored away for as long as may seem expedient. The consumers' names, addresses, etc., are put on the machine by the addressing machine in the same order as on the binders and stored away for as long as may seem expedient. The consumers' names, addresses, etc., are put on the machine by the addressing machine in the same order as on the bills and the meter readers' cards. The date, the meter reading, the amount consumed and corresponding charge are entered by the bookkeeping machine, which quickly balances by page, street or ward. The whole scheme is working out very well. The entire city is metered, which, I think, simplifies the bookkeeping of a water bureau.

Overcoming Opposition to Metering.—When we started the campaign for universal metering we went at it in the directly opposite method to the generally accepted plan, i. e., of metering the worst places and the most flagrant wasters of water first. We took at the beginning the better class of homes with the most modern plumbing and the more intelligent class of occupants. In a great many of these places, the water bills under the meter rates were not materially changed from their old rates and oftentimes the bills were smaller.

It was not long before we had a great many meters installed without any serious opposition on the part of the consumers, and the more we installed the greater argument we had for putting in still more and getting everyone on the same basis, so that when we finally got down to the tough customers—those careless property owners with poor plumbing and wornout fixtures—who were extravagantly wasting water, they had no argument in their opposition to meters, and the majority of citizens were against them.

Our own meter men did the installing of all the meters and I think did it much better, cheaper and faster than if we had had it done by contract, and we were able to keep better records of the meter installations. With three teams of two men each and a wagon, we averaged about 18 meters set a day—our record was 30 in one day. Our consumption is between 90 and 100 gal. per capita per day. Besides the sprinkling of the streets, we do a great deal of washing and flushing of the paved streets and are very generous in our use of water for parks, public bath-houses, drinking fountains and the like.

How Fire Hydrants Are Kept in Condition.—We are also perhaps rather lenient in our hydrant rules. It has finally seemed to the writer impractical to keep the operation and use of hydrants confined to the fire and water departments. The street department with the sprinkling and cleaning of streets and flushing of sewers, and the public utilities corporations, such as the gas, electric and street railway companies, and the contractors on street improvements, all have to use water in the streets more or less frequently, and the hydrant is the most available and often the only means of obtaining water.

With the beginning of spring, therefore, for such purposes, we attach to the nozzles of a great many hydrants a 2½-in. substantial valve, and on request other smaller or so-called contractors' valves. Neither of these has to be removed in case of a fire and they do not hinder the operation of the hydrant by the firemen. We have a certain number of men constantly looking after the hydrants, and with this method manage to keep them in pretty good shape. In winter these men with additional ones are kept constantly on the go to prevent or report frozen hydrants.

Maintenance of Mains and Sewers.—Repeated surveys show comparatively little leakage from mains and services, and all leaks and breaks when disclosed are fixed as promptly as possible. Considering the good condition of our piping system and the care we use to keep it so, I have come to the conclusion that a rate of 100 gal. per capita is a fairly low one for cities of about 300,000 population or larger.

To properly maintain the system of mains, valves, hydrants, services, etc., of a water system, it is very necessary to have a good repair force; one of sufficient size and always available. In addition to our regular day force we always have on hand at nights, Sundays and all other holidays, a certain number of men ready for emergency calls, and the whereabouts of most of the others is known so that they can be gotten hold of by telephone, automobile or the like in case of necessity. The key to our repair shop was practically thrown away 40 years ago and the door has never been locked since then as someone is always there ready for action.

---

*Abstract of a paper presented June 24 at the convention of the American Water Works Association.

Unfortunately, no one has yet been able to foretell where or when a water main is going to break. In a general way the old experienced water works man will tell you that they always break on the busiest corner of the most congested street on the coldest day of the year, with the crowds standing around wondering why it takes so long to shut the water off. It always does seem a fearfully long time before the gates can be closed, but I think as yet there is no better or quicker way than the old familiar, laborious method of hand-operation; there is no method which would not be so excessive in cost that the expense would far out-weigh the advantage gained by speed or ease of operation.

The speed in shutting off mains can be greatly helped if gates are properly located and easily found and the men thoroughly familiar with their operation. The gates in the large mains should be especially known and kept in working order. Care should be taken that they are not needlessly obstructed by building operations or rendered inaccessible in any other way. I call to mind that once when a 36-in. main let loose, one of the gate covers as well as the whole street was quickly covered with a foot or two of rushing water, and another gate up the street a block or two, was surmounted by a large temporary election voting booth which was too heavy to move without jacks. The water covered gate could not, of course, be helped, but the placing of the election booth where it was, never should have been allowed. It was what might be called a political blunder, a thing not unknown to the water works superintendent.

The number of bursting mains per mile of pipe per year, is after all, in spite of appearance, not so alarming. We have averaged about seven per year for the last four or five years for some 500 miles of pipe. All sizes and kinds break and the larger ones do not always cause the most damage. It depends on the locality principally. The last serious break was in a 12-in. wrought iron main, which was caught by the long-drawn-out severe weather of the past winter. As a result of freezing and bursting it had to be repaired or replaced at several different points. All this raises the question of insuring water mains against breaking.

Further Details Regarding the Federated American Engineering Societies

In bulletin No. 2 of the Federated American Engineering Societies, issued under date of July 16, by the Joint Conference Committee, further information regarding the new society is given. The following is quoted from the bulletin:

Object of the Society. The object of the Federated American Engineering Societies as declared in its constitution, and as has been repeatedly stated.

"Shall be to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions."

Notwithstanding this, the statement is repeatedly made that the organization does not deal with the interests of the individual engineer and of the allied technologists. The purpose of the organization is that of service first to the nation, state and community, and second to the profession which obviously must include the interests of the individual. While it is true that it does not deal with the interests of the engineer and technologist as does a labor union for its member, nevertheless its work will do more ultimately to advance the interests of the individual than a labor union could possibly do, because the advancement of the profession through a greater recognition by the public of the engineer and allied technologist, and the greatly increased solidarity and higher standards of these professions must unquestionably work for their ultimate good.

Not a New Organization.—The Joint Conference Committee, among others, has referred to the Federated American Engineering Societies as a "new" organization. This is not strictly correct. While the name is new, the organization will be a successor to the existing Engineering Council, whose work will be amplified and carried on on a much more extended plan as to scope and membership.

How and Why the Name Was Selected.—There has been considerable comment on the name of the new organization. Probably no detail caused the Committee on Constitution and By-Laws of the Organizing Conference, more serious thought than the question of a suitable name. The purpose was to secure a short title that could readily be used, and many suggested names were rejected for good and sufficient reasons. The committee decided that the name of the organization should be indicative of its character, based on the fundamental resolution of the organizing conference, that it should consist of societies and not of individual members. The words "Association," "Confederation," "Federation," and others were suggested and considered and all were rejected and finally as a compromise the word "Federated" was unanimously agreed to. In view of the fact that other countries are looking with interest on this movement with the probability that there will be similar organizations formed in those countries, it was felt desirable that some distinctive name should be given the organization in this country, and so the word "American" was inserted. Objection to this was made on the ground that this country is the "United States of America," but the answer was that the soldiers of this country fought in Europe as "The American Expeditionary Forces" and have been internationally so recognized. It was thought undesirable to use so long a name as Engineering and Allied Technical Societies, especially in view of the fact that engineering as defined in the preamble of the constitution is an all-inclusive word, and it was, therefore, decided to use only the word "Engineering" in the title. Hence the name "The Federated American Engineering Societies."

It is probable, however, that when the organization begins to function it will be referred to rarely as the Federated American Engineering Societies, but will be called the American Engineering Council, which is the executive body of the organization.

Basis of Representation.—There seems to be difficulty in understanding what the basis of representation should be where a state organization exists and where there are also strong local organizations and affiliations. The constitution provides that a state council or organization, representative of the engineers and allied technologists in the state, can be represented on the American Engineering Council on the basis of all the engineers and allied technologists in the state. If, however, there exists a strong local organization or affiliation which elects to have its own representative or representatives on the council then the state council or organization is entitled to representation on the basis of all the engineers and allied technologists in the state, less the engineers and technologists that are to be represented through their local organization or affiliation. This will not prevent the local organization or affiliation from participating in the work of the state council or organization in the consideration of matters affecting the state only.

No Provision for Dues.—The Joint Conference Committee has received several letters inquiring as to the provisions for dues. The constitution and by-laws provide for funds contributed by the member-societies for the support of the Federated American Engineering Societies. Inasmuch as it would be unreasonable for a small local society to pay as large a contribution as a national society the constitution provides that the contribution shall be on the basis of the number of members in the organization at the rate of $1.50 per member for national societies and $1 per member for local, state and regional organizations or affiliations. The individual, therefore, does not directly pay any dues but the member-society of which he is a member contributes to the support of the Federated American Engineering Societies on a per capita basis of its membership. It, therefore, follows that any one who is a member of several organizations which hold membership in the Federated American Engineering Societies will be counted in the total membership of each society as a basis of its contribution.

Organization Not Cumbersome.—It has also been stated that "the machinery proposed is somewhat elaborate and appears to be cumbersome and expensive." The Joint Conference Committee can see no [illegible] for this statement. The by-laws provide that

"Any society or organization of the engineering or allied technical professions whose chief object is the advancement of the knowledge and practice of engineering or the application of allied sciences, and which is not organized for commercial purposes is eligible for membership."

The Federated American Engineering Societies will function through the American Engineering Council which will meet either annually, or biannually as it will determine. This American Engineering Council will consist of representatives from the member-societies on the basis of one representative for from 100 to 1,000 members and an additional representative for each additional 1,000 members or major fraction thereof. From this body of representatives will be formed an executive board of [illegible] consisting of [illegible] officers and 21 other members selected in part from the national societies and the remainder from the local, state or regional organizations or affiliations. The plan reported by the Committee on Constitution and By-Laws provided that the representation on the Executive Board should be based on the ratio of the total number of members in the national societies to the total number of members in the local, state and regional organizations or affiliations. The organizing conference, however, changed this to the ratio of the number of representatives from the local, state and regional organizations or affiliations, on the American Engineering Council. This Executive Board will meet monthly or as often as may be found to be necessary to properly transact the business of the American Engineering Council. There will be an executive officer who will also be the secretary of these bodies and who will be entrusted with carrying out their instructions.

As a matter of fact, the American Engineering Council thus created is less cumbersome or unworkable than the present Engineering Council; furthermore it has the distinct advantage of being more democratic and broader in its scope and membership.

Organization Conservatively Financed. As to the statement that the organization is expensive, it is pointed out that on the basis of the present membership of Engineering Council the income from the contributions provided in the constitution of the Federated American Engineering Societies would be about $75,000. At no time in the history of its existence has the budget of Engineering Council exceeded $50,000. Provision is made, however, that

"The Executive Board shall, wherever practicable, provide for the whole or a part of the expense of members or of representatives attending its own meetings and those of the Council."

On the basis of past experience, it is estimated that if the expenses of all the representatives on American Engineering Council and of the members of its Executive Board were paid to each meeting of these bodies there would be involved an annual expense of about $25,000. The purpose of these expenditures was to secure a full attendance of the representatives of the American Engineering Council and on the Executive Board especially during the earlier years of the organization. As will be noted in the excerpt from the constitution the expenses of representatives of the council and members of the Executive Board will be provided from such funds as may be available. If in the judgment of the Executive Board, this money should be required for more urgent work the expenses of the representatives and members would not be provided for. It seems to the Joint Conference Committee that it would be highly desirable to have sufficient funds to pay the expenses of this representative body of men who contribute their time for the good of engineering and allied technical professions. The payment of these expenses is the only part of the organization that can be said to be expensive.

Organization Democratic, Not Autocratic.—It has also been stated that the form of organization that has been set up is "autocratic, not democratic."

If a democratic organization is taken to mean one in which its constituents have a voice in its affairs then the Federated American Engineering Societies is truly a democratic organization. Member-societies of this organization are represented on the American Engineering Council which has full power to control and to direct the activities of the American Engineering Council and of its Executive Board and can determine whether it is necessary for the former to meet annually, biannually [illegible] or more frequently the latter shall meet.

The Opportunity.—The Joint Conference Committee is unqualifiedly of the opinion that an opportunity has been created for bringing about a solidarity of the engineering and allied technical professions that has never heretofore been available and that the success of the movement will depend on the whole-hearted support of each American engineer and of each technologist. He who is determined that this movement shall succeed will obviously not bother with the details or the form of organization in his effort to secure the end desired.

Experiences in Metering Fire Services*

FREDERIC E. BECK

Chief Engineer Consolidated Water Co., Utica, N. Y.

After experimenting for several years in an endeavor to find some method whereby the flow of water through strictly fire-service lines could be controlled and the amount of water used or wasted through such lines obtained, it was decided early in 1919 that the only positive method of obtaining this information was to install meters on all fire-service lines connected with our mains.

In making this decision to install meters on all fire-service connections, of which we have 230, we were governed by the fact that we had positive knowledge that large amounts of water were being either used or wasted through these lines. This information was obtained from time to time by means of the pitometer survey which we were making, in order to reduce our underground leakage, together with the visible evidence of seeing roofs wet down during the hot summer days, several fire streams being played simultaneously on huge coal piles for days at a time, and such other like usage of water which might be taken from our mains without our knowledge and without payment for the water used.

On investigating cases of this kind, we usually found that the water being used was supplied by pumps on the secondary source of supply, which in our city is a near-by canal and was not taken from our mains. In several cases, however, the flow was entirely from our mains, and taken through fire-service connections.

In order to lighten the financial burden of metering 230 services, it was decided to first meter those plants having outside yard systems, where the chance of underground leakage was greatest, and to proceed with the metering of the balance of the services at a rate that would insure the complete metering of all services within a period of four years.

During the past season 30 fire-service meters have been installed, and the results obtained certainly warrant us in the completion of our program.

All meters are located as near the street line as possible, and are placed in brick or concrete pits; and all expense and cost of setting, including cost of meter, is borne by the company, a nominal service charge being made for each service, in addition to requiring payment for all water passing through the meters, excepting that used for the extinguishment of fires or the testing of the equipment. In case of fire or testing of equipment, the consumer is required to give notice on cards furnished for the purpose, which show the time and duration of the fire. The allowance for water used for these two purposes is then based on the normal flow of water through the meters, as shown by previous meter readings.

The annual service charge for fire-service connections is $40 for 4-in., $50 for 6-in., and $75 for 8-in. connections. In defense of this low service charge it is necessary to state that all fire-service connections are made at the expense of the consumer from the main to the property line. I am not, however, defending this method of installing services at the expense of the consumer, but simply our low service charge.

The cost of installing the meters on service lines already in use has averaged $153 for 8-in. meters and $135 for 6-in. meters, with a range of from $80 to $239 on the 8-in. size and from $75 to $182 on the 6-in. meters; these prices do not, however, include pavement replacement, but include all other labor and material costs for placing meter and constructing meter pit.

---

*From the June Journal of the New England Waterworks Association.

On the 50 meters installed, all but three show a constant flow of water, the three exceptions being new connections to buildings having no yard system and but small sprinkler systems. The rate of flow through the fire-service connections varies from 6 to 3,000 cu. ft. per day.

But little opposition has been encountered from the owners or managers of the plants metered, and where the flow of water could not be traced to unknown connections with the fire-service pipes, they have been extremely anxious to locate and repair any leaks which might cause a loss of water.

In view of the results obtained on the 50 services metered, I would advocate the placing of properly designed meters on all fire-service connections and especially those having extensive systems of piping with yard hydrants attached.

Edison's Achievements Due to Study and Hard Work

In a recent issue of the Public Ledger, Mr. B. C. Forbes, a well-known financial writer, gives some interesting information regarding Thomas A. Edison. We quote from his article as follows:

I have talked with many men of notable achievement in this and other countries, but I have found none so interesting, so stimulating and so invigorating as Edison. I had a long, intimate session with him the other day; and although he is past 73, he displayed more mental vitality, more vision, more foresight and more enthusiasm than any other man, young or old, whom I have ever known. He is as dynamic as any dynamo he ever constructed, as bright as the incandescent light which he gave to mankind, as animated mentally as the swiftest moving picture his ingenuity has made possible.

There is a reason for everything in this world, if we can only find it. I have always been anxious to fathom the reason for Edison's unparalleled achievements as engineer, chemist, electrician and inventor. I think I now know.

Some of us who have failed to do anything out of the ordinary like to minimize the achievements of others by attributing everything to heredity or to "natural talents." We say that such men were born that way, that it was in them at birth, and we sort of imply that they deserve no special credit for what they have accomplished. Without attempting to deny for one moment that all men are not born with equal mentality, my observation and analysis of the careers of many men of conspicuous achievement convince me that those who have done unusual things have had to put forth unusual effort. They have possessed no Aladdin's lamp. They have led no lily life, toiling not nor spinning. They have not gone through the world with folded arms, simply allowing Fortune to shower gifts upon them without effort and without cost.

Edison himself attributes his achievements to hard, unremitting work. He spurns the idea of being a natural-born genius. Genius, he declares emphatically, consists of only 1 per cent inspiration and 99 per cent perspiration. Coupled with hard working there must be hard thinking, Edison admits. In fact, the very first theme he opened up was the startling aversion on the part of people today to serious, sustained thinking. If he were to put his recipe for success into two words, the two Edison would choose would be, "Think, Work."

I believe, however, that I can go a little farther than that in accounting for the phenomenal success which has crowned so many of Edison's efforts. Just impressing upon one to work hard and think hard doesn't help much. It isn't very illuminating. It's too vague. I have spent much time and serious thought on the study of Edison's career, so that before our heart-to-heart talk I had formed certain conclusions. These conclusions were confirmed in the first half dozen sentences Mr. Edison uttered. After telling me that he read my writings and found them helpful, he added:

"I read [illegible] trade journals regularly."

He reads, too, the foremost business daily newspaper in the country, even following many of its quotations closely. He devours every conceivable kind of book bearing upon electricity, engineering and chemistry—anything and everything, in short, which might have the slightest bearing upon the million and one things in which he is intensely interested.

Edison might have worked as hard as he has worked and might have thought as hard as he has thought, but I, for one, am convinced that unless he had from the start set himself determinedly to gather and master all the other useful knowledge discovered by others he never would have reached his present pinnacle. When a mere lad, acting as newsboy and "candy butcher" on the Grand Trunk Railway trains running between Port Huron and Detroit, Edison utilized his time, while waiting for the return trip, to read every book in the public library. He started at one end of the building and went clear through to the other, missing nothing.

Edison never wastes time or effort attempting to accomplish or to discover anything which has already been accomplished or discovered. Life, he reasons, is too short for any man to endeavor to find out by slow, painful processes that which has already been ascertained and established. He refuses to grope in the dark along any path which has already been lit up by others. Time and time again people, both outside and inside his own organization, have come to him with devices in the making and asked for his opinion on their feasibility, when his reply has been: "Go to such-and-such a shelf in such-and-such a library and there you will find your device fully described by So-and-So. This job has already been done."

How does this omniverous gathering of knowledge from the world's storehouses and this constant keeping abreast of events and developments in all varieties of industry work out helpfully to Edison? I had asked him how long it took him, on the average, to produce one of his inventions. "Seven years," was his prompt reply.

Then he added: "There are some things I have been working on for 25 years and they are not finished yet. Sometimes I run bangup against a granite wall 100 ft. high and I simply can't get over it. All right; I turn to something else. And then some day I may be reading a trade journal or a newspaper or a book and I see that some one has done something or something has happened which I can see will help me to climb at least part way up the face of the 100-ft. wall. I start in again, apply myself to the problem, sometimes working four days without a break; and then I may finally reach the top of the wall and get over it successfully."

It is not uncommon for Mr. Edison to conduct 10,000 experiments before attaining an object. He has even conducted as many as 50,000 experiments before getting an invention to work satisfactorily. Talk about stick-to-itiveness—Edison is the very embodiment of it.

When Cecil Rhodes, the empire builder of South Africa, was on his deathbed, he exclaimed: "So little done! So much to do!" Edison feels very, very strongly that so little knowledge has been ascertained and that there is so much yet to learn. "We don't know one-millionth of 1 per cent about anything," he declared. "We are still in the chimpanzee state mentally." Edison is so anxious to add something to mankind's sum total of knowledge that he will not, as already stated, laboriously cut his way through thickets which have already been cleared. He seeks knowledge wherever it has been already found; and then, having checked up their data, starts where the others have left off. He sometimes hies himself to a secluded spot and and indulges in a spell of thinking which may last several days. "Thinking is the greatest fun in the world," he told me. "I don't need to be constantly entertained. I can get my entertainment from thinking."

Another thing which struck me about Edison was his enthusiastic looking forward. He scours the whole past of the whole world for light to illumine the pathway of the future. The past, indeed, is useful, in Edison's eyes, only in so far as it facilitates present and future advancement. Most men, after having passed the Psalmist's allotted span of "three score years and ten," let their minds dwell almost solely on the days and events that have gone. Edison's face is toward the future as eagerly as a youth's of seventeen. He has enough work on hand and in his head to keep him going years and years. He is a progressive of progressives.

One could go on and on writing about this remarkable man, but all that is possible here is merely to outline Edison's make-up and methods so as to afford some pointers for others, including business men.

Many of us are too lazy or too indifferent or too shortsighted to gather and master every available speck of information and knowledge concerning our own line of activity. We may work never so hard and think never so hard, but we don't take one-tenth the pains [illegible] take to equip ourselves to the fullest degree for [illegible]. We are too self-centered, too shortsighted, too [illegible], sometimes too bigoted, imagining that it is not necessary for us to read voraciously with a view to obtaining enlightenment from the experiences of others.

Until recent years business men paid very little attention even to business news and developments. Up-to-date business organizations now make a [illegible] effort to collect and collate news and data having [illegible] upon their affairs or their problems.

If Edison, with all his wonderful mental powers, finds it profitable to read 52 business publications regularly and to dissect no end of books and other publications, does it become the rest of us to be content to grovel and grope along without all the outside light we can bring to our paths?

Engineering Costs, Fees and Services

By J. W. CUNNINGHAM

Engineering Costs.—Engineers have unwittingly worked against their own interests by quoting and in fact boasting of low engineering costs for work done under their direction. While those costs may in fact have been the result of efficiency, they also may have been governed by several other factors, and equal credit might have been secured in other ways, by pointing to the excellence of the design and construction and to the low total cost.

The legal and medical professions have long ago learned that it was poor policy to emphasize the low cost of their services. A lawyer will point with pride to difficult cases won but does not say how cheaply they were handled. Similarly in the medical professions, the only individuals who publicly advertise the inexpensiveness of their work are those so-called "specialists" who are in fact unscrupulous "quacks" and are condemned as unethical by the rest of the profession.

It is perhaps through unwise advertising by engineers themselves that the public has become accustomed to thinking that engineering costs should average about 5 per cent without regard to their character. In the mind of many a layman, an engineering cost less than 5 per cent is an evidence of efficiency, and a cost exceeding that cause for protest. The truth is that where inspection and supervision are included only a few classes of engineering work can be handled for a cost as low as 5 per cent.

In large structures where the work is concentrated and the surveys and inspection necessary is limited, 5 per cent may be an adequate fee. Also in projects, where machinery is a large element or for example, in bridges, where duplicate spans are used and the shop details are made by the manufacturer, 5 per cent may be sufficient. In municipal work, irrigation or drainage, railroads, highways or most any branch where the work is scattered and requires extensive surveys, studies and inspection of small units, 5 per cent is entirely inadequate and engineering costs will run to 10 per cent or higher.

The layman seldom appreciates that high engineering costs in very many cases bring about low ultimate and total costs. The truth is that those projects upon which the preliminary work has been stinted are really the most expensive in the long run. After an engineer has given the usual amount of time and study to a proposition, he can usually, if permitted further study of the subject, introduce refinements and economies which much more than pay the cost of these additional studies. For instance, in railroad location, if the time element be eliminated and the engineer be permitted to run alternative lines and refine location and balance his quantities, he can almost invariably make a very material saving amounting to several times the total engineering cost.

Where an element of risk is assumed a contractor is considered as entitled to a profit of from 10 per cent to 20 per cent. On the fee form of contract, with superintendence, equipment rental, and financing eliminated from the fee, and no risk involved, as high as 15 per cent has been paid, and 10 per cent is common. Certainly the engineer, who conceives the project, works out its complete design, and oversees its proper and successful construction, assumes as much responsibility as the cost plus or fixed fee contractor. Yet the engineer, before he can count his actual profits, must deduct from his 5 per cent, [illegible] per cent or very seldom 10 per cent his expenditures for salaries of draftsmen, field engineers and assistants, board, transportation costs, office rental, stationery and drafting room supplies, stenographer and office overhead, instrument rental and repairs, stakes and field supplies, blue printing, industrial insurance on field parties, and other items too numerous to mention.

In comparison with engineering fees there may be cited the brokerage discount on bond sales, which often runs as high as 10 per cent covering some element of risk, but no greater chance than is taken by engineers.

Real estate transactions customarily pay 5 per cent where the only service of the agent is to bring the two parties together. Salesmen in commercial lines receive commissions in a considerable fraction of the cost of the commodity handled. Promoters of industrial undertakings cut in on the profits to a very substantial extent and promotion cost is recognized as a legitimate one in valuations.

Surely the engineer, who assumes very definite risks, who in his designs gives his client some of the ingenuity of the inventor, who in his estimates acts as a trusted financial advisor, and who exercises the function of a general manager on construction, deserves to be paid materially more than he has been getting in the past.

Compared with the returns granted for the use of initiative and the taking of responsibility in other lines, engineering fees are sadly inadequate. In reality, for the average project where full services are given from start to finish, an adequate compensation to the engineering or engineering firm in charge would be 5 per cent over and above all accompanying engineering costs. The total engineering costs should run seldom less than 10 per cent. Under these conditions, the preliminary investigations, and the designs, tests and supervision of construction should be conducted with such care that engineering failures will be almost unknown, and occur from natural causes beyond any possible control of the engineer. Furthermore, it is the confirmed belief of the writer that these higher engineering costs will on the average and in the long run mean actually lower total costs of the completed work.

Fees for Practicing Engineers.—Little can be achieved by talking indefinitely about "lack of recognition" and "need of greater compensation" for engineers. In order that we may tell others what we want and deserve, we must first formulate our own ideas on the subject.

Schedules for engineers' salaries in railroad, highway and municipal fields have been proposed by the American Association of Engineers. They set standards which while equitable are generally in advance of the rates now current, and the gradual working toward these ends will be the basis of real progress. Similar schedules on a fee basis should be developed for practicing engineers, and the American Association is certainly the proper organization to give such a schedule the thorough publicity, and the powerful backing which is necessary to secure its general adoption.

Such a schedule must perforce be a rather complex one, as there are many factors to be considered. The element "value" of services should be given greater weight than time. Even for the same amount of actual detail work required the fee should be greater for the large undertaking than for the small one. The responsibility assumed and the special knowledge acquired from past undertakings should be capitalized.

Percentage fees have been widely adopted in the past. They have the merit that they recognize at once the greater responsibility of handling the more costly undertakings. Where percentage fees cover detail work and services of subordinates, they must necessarily be found on a sliding scale with the greater percentages for small projects which in many features necessitate as much actual work as larger ones. Percentages for different classes of work and even for different undertakings in the same class must have a measure of flexibility to take account of the special problem involved.

A per diem rate for engineering services is necessary for many undertakings where the extent of the work cannot be predicted in advance. The per diem charges will depend upon the importance of the work and the experience and standing of the engineer employed. Unlike percentage fees, per diem rates do not depend directly on the magnitude of the work, and do not take account of price fluctuations. Therefore the schedule adopted for present day conditions should range from 50 to 100 per cent above what was reasonable for pre-war times.

---

*From a paper, "Some Problems of the Practicing Engineer," read before the Oregon Chapter of the American Association of Engineers.

Engineering undertakings must deal with natural obstacles which cannot be predicted with absolute accuracy, and for which the engineer is in no way responsible. The engineering services and skill required cannot be exactly foreseen at the initiation of a job. Percentage fees entail an element of risk. Per diem rates obligate the engineer to perform services of unforeseen value or responsibility at a set figure. Such gambling elements are not truly consistent with professional services.

The ideal compensation for engineers is a flat fee to be fixed at the conclusion of the work and after all of the contingencies have been passed. This plan is the accepted one with the legal and medical professions, whose most reputable members will refuse to set a figure in advance of the conclusion of a case. It is equally applicable to engineering work. It implies the obligation which already rests upon engineers as professional men, to give their best efforts in the way of services, and to evaluate them at a fair figure, not too high which would be extortion and not too low which means loss of self-respect and public appreciation.

A recognized schedule of what constitutes fair engineering fees will be a protection to engineers both from within and without their own ranks. It will give some foundation for "calling" the man who undertakes work too cheaply, and who must therefore either neglect to give full service or operate at a loss or an inadequate compensation. It furthermore gives a firm ground for fixing the fees asked of clients. The inevitable attempt to bear down on the price may be met by fixed refusal, with the feeling that your competitor will not cut under your price. The maintenance of such a schedule will necessarily bring a certain responsibility upon such an organization as the American Association of Engineers, which must at times take some action of reproof or discipline upon those who fail to follow the wishes of the majority.

Engineering Service.—The adoption of a set schedule of engineering charges may be opposed by some on the ground that it is a form of collusion or conspiracy and against public policy if not actually illegal. Such is absolutely not the case. Engineering service is not a commodity of rigid qualities and dimensions. Uniformity of price may and will be accompanied by the highest form of competition in service. This form of competition is the end to which we all should work.

When a prospective client reasons that all charges being equal he will choose "John Doe" because he renders the most conscientious service, he has acquired a true appreciation of the engineering profession.

Along with the inevitable competition of service there should, however, for the good of the profession, be maintained a certain minimum quality of service. A case where inferior service is an injury to us all is that of one engineer in the municipal field who takes work on a percentage to cover full preliminary and construction service. He prepares plans and specifications, but when it comes to construction gives only the most casual oversight and inspection. The result is numerous jobs of inferior quality which discredit engineers in general. This individual should be made to feel in an unmistakable way the disfavor with which reputable engineers look upon his methods.

An occasional error in judgment on the part of an engineer can be condoned but the engineer in or out of private practice who knowingly slights his work gains temporary profit at the expense of reputation, both his own and that of engineers in general. If an engineer cannot secure a fee which will enable him to do a job justice, he had better turn it down entirely. Every piece of work done should represent his best efforts. Engineers should demand adequate and in fact liberal compensation but in return for this the client deserves the utmost efforts in the way of "Service."

There have been many efforts in the past to point out a fundamental line of distinction between the engineer and the tradesmen, and to show why the American Association cannot align itself with trades union. The argument that the engineer is an arbitrator between capital and labor is a catchy one, but will not stand analysis, for in truth he seldom exercises such a function.

If he will consider the original division of industrial effort among the trades and guilds, and follow the development through to the modern specialization and organization of trades, vocations and professions, he will find that the American Association has an ancestry not so far removed from that of the plumbers or the hod carriers. It is nothing to be ashamed of at that, for the surgeon we remember started as a barber and the original lawyer's only qualification was the ability to read and write, not common at that day.

The breach between the American Association and the trades union is not a matter of form, but of performance. We object to be classed with the unions not for what they are, but for what they do. The majority of trades unions are run for purely selfish motives, and without consideration for society at large. Strikes which bring suffering upon the innocent public, limitation of production, violence and other practices have brought disfavor from a public which is inclined to support labor's claim along many lines. The trades union, furthermore, have almost entirely drifted from the old aim of the guilds, to develop more efficient workmen. The union aim is more often to reduce than to increase efficiency and production.

The American Association demands a square deal for engineers. Like the trade unions, it considers compensation and working conditions, but proposes to get results by methods which will gain engineers the respect and not the disfavor of society.

Our most fundamental distinction from the unions comes, however, in this matter of service. Our first aim is to raise the standards of ethics of the engineering profession. We want public recognition, but we want also to deserve it. If we allow our claims for better compensation to receive emphasis above all else, we are exactly following the lead of the unions. If, however, we carry along at the same time a well worked out campaign for better engineering service, we will have distinguished ourselves in an unmistakable manner from the organizations for selfish ends alone.

A "Slight" Newspaper Mistake on a Cost Plus Contract.—There was a statement in the papers some months ago that Uncle Sam had been wasting about $11,000,000 on a cost-plus contract. It was in this district. Some three days later, I happened to receive reports which showed that the total expenditure amounted to $3,365,000. I also happened to know that the total profit on this $3,365,000 job was a little less than $28,000, so I addressed a little line to the papers in Philadelphia, but they did not want to spoil a good story. The cost-plus contract is necessary at times, and is a good thing if properly handled. You have to pay for the time element. You can walk from here to North Philadelphia; or you can go up in a street car for 5 ct. I think if you use the railroad it costs you 17 ct. You can hire a taxicab. You get there quicker with a taxicab, but it costs you more money, and that is precisely the case with the cost-plus contract. There is nothing against it if the Government is able to set agoing its procedure for handling these cases, which provides for proper authorization for all that is spent. In all of these cost-plus contracts, the Government was safe; it practically eliminated the percentage; for it had a little proviso in connection with all war work—that 80 odd per cent was to come back any way in the form of surplus war tax. It stands out clearly that with no proving grounds, experimental stations and laboratories, there were many things that we did not know, and we stood to make mistakes.—John C. Jones in address before the Engineers' Club of Philadelphia.

Town Manager Plan for Westfield, Mass.—At a special election July 12 the town of Westfield, Mass., voted to adopt the town manager form of government by 508 affirmative to 255 against. Mansfield is the third municipality in the state to take this form of government, Waltham and Norwood being the other two. The town manager will be appointed by the Selectmen and the other town offices will be filled by the town manager with the advice of the Selectmen, except that the School Committee will be elected and the town treasurer and the collector of taxes be appointed solely by the town manager.

Construction Methods on Three Recent Earth and Concrete Dams

By JAMES P. [illegible]

Consulting Engineer, Cutler [illegible]

During the past four or five years the writer has had occasion to design and supervise the construction of several earthen dams with concrete cores. It has occurred to him that the different methods used in the construction of three of these dams which are quite similar in design might be of interest to those contemplating similar structures. The methods of making the earth fill in each case are particularly interesting.

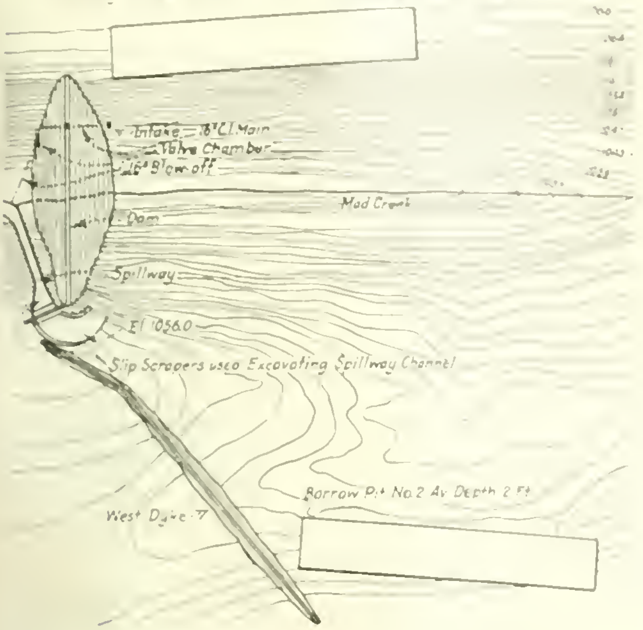

Elevating Grader Used Borrow Pit No1 Av. Depth Excavation [illegible]
Intake 18" C.I. Main
Valve Chamber
16" Blow off
Mud Creek
Dam
Spillway
El 1056.0
Slip Scrapers used Excavating Spillway Channel
Borrow Pit No.2 Av. Depth 2 Ft
West Dyke

Fig. 1—Le Roy Dam, Showing Borrow Pits.

All three dams were built in New York State and in about the same latitude, the Le Roy dam and the Newark dam in Western New York, and the Johnstown dam in Eastern New York. All three are for the purpose of impounding water for municipal water supplies. The capacity of the Le Roy and Johnstown reservoirs is about [illegible] gal. and the capacity of the Newark reservoir about [illegible] gal.

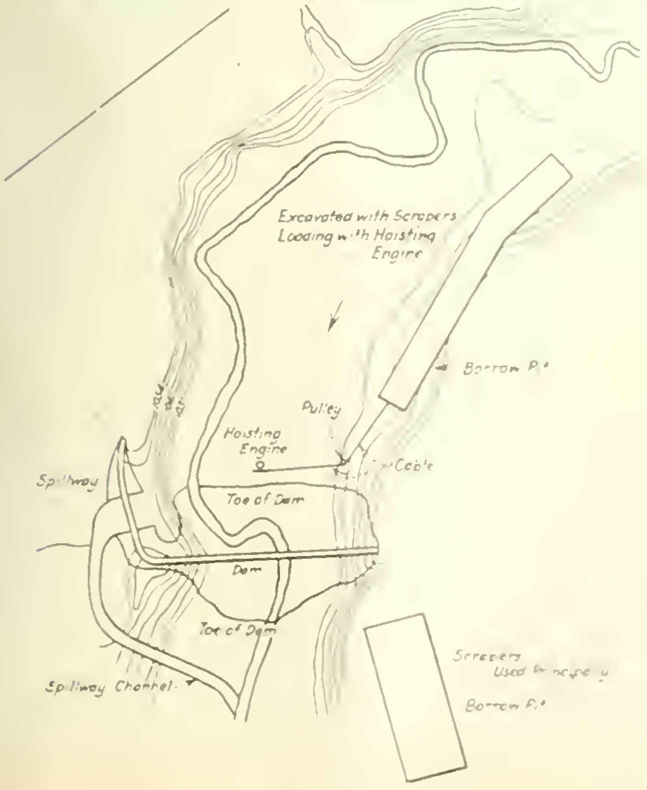


Fig. 2—Johnstown Dam Layout.

Le Roy Dam. This dam was begun in September, [illegible], and practically completed in December of the same year. It has a maximum height of [illegible] ft., a length of 500 ft. and contains about 25,000 cu. yd. of earth embankment and about 2,000 cu. yd. of concrete. In addition to this a dike with a maximum height of 10 ft. was also constructed. The material for the greater portion of the dam was taken from borrow pit No. 1 (see Fig. 1) by means of an elevating grader hauled by a traction engine and loading into dump wagons. Most of the material which went into the dam was of a heavy clayey nature. Considerable difficulty was experienced in operating the grader whenever the borrow pit was wet. The construction work had to be carried into freezing weather and considerable frozen earth was put in on the upstream side of the dam. Although during the construction the embankment was wetted and rolled with a grooved roller, there was some settlement in the following year due to the thawing and settlement of the frozen earth. There was a crack along each side of the core wall about a foot wide. The embankment settled from 2 to 3 ft. at the central portion of the dam.

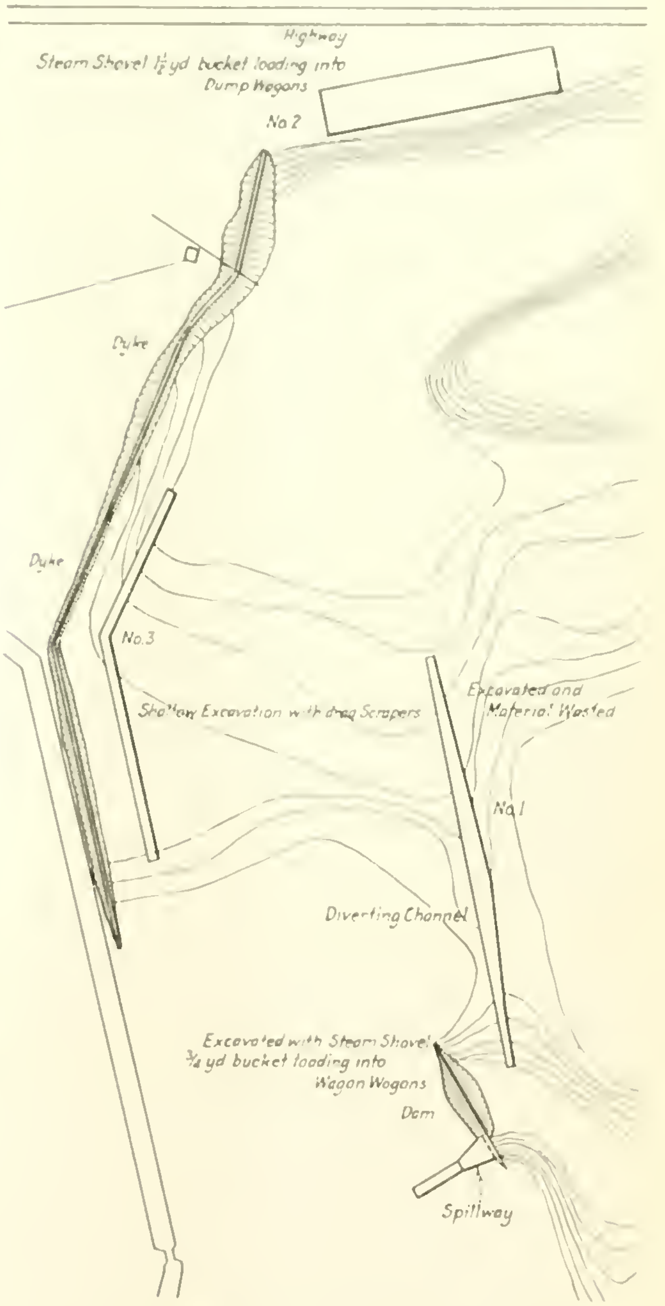

Highway
Steam Shovel 1½ yd bucket loading into Dump Wagons
No 2
Dyke
Dyke
No.3
Shallow Excavation with drag Scrapers
Excavated and Material Wasted
No 1
Diverting Channel
Excavated with Steam Shovel ¾ yd bucket loading into Wagon Wagons
Dam
Spillway

Fig. 3—Newark Dam, Showing Borrow Pits.

Johnstown Dam.—Construction work on this project was begun in April, 1918. The work was closed down for the winter and it was completed in the latter part of August, 1919. This dam has a maximum height of about 50 ft. and is about 450 ft. in length. It contains about 50,000 cu. yd. of earth embankment and about 6,000 cu. yd. of concrete. The material for the dam was sandy loam mixed with gravel and a small per cent of clay. All of the earth embankment was put in with scrapers, part of it with Maney scrapers and part with Fresno scrapers. The material was obtained from two borrow pits. One of these, located on the up-stream side, was long and narrow and all the material was located below the level of the top of the dam. The material from this borrow pit was excavated with Maney scrapers, loaded with a hoisting engine. They made an excellent compact bank as the front wheels of the scrapers were nearer together than the rear wheels so that each scraper made four tracks. The material in the borrow pit in front of the dam was practically all taken from a level higher than the top of the dam. Fresno scrapers with a 3-horse hitch were used, and towards the latter part of the work Maney scrapers were also used with an extra team to load the scrapers. Very little settlement whatever occurred in this embankment even at the portion where it was 50 ft. in height. The continual pounding of the horses' hoofs and the added effect of the wheels of the scrapers make a very compact bank.

Newark Dam.—Construction work on this dam was begun in June, 1919, and it was practically completed in the latter part of November of that year. It contains about 35,000 cu. yd. of earth embankment and about 3,000 cu. yd. of concrete. The material in the dam is clay loam mixed with a small per cent of gravel. Unlike the Le Roy and Johnstown dams which are of relatively short length, the dam at Newark is over 3,000 ft. in length and for the most part quite low. The highest portion is 25 ft. The embankment in the diversion dam, as distinguished from the dike, was constructed of material from borrow pit No. 1, shown in Fig. 3. The borrow pit would not be of this shape but for the fact that a channel had to be cut through at this point to carry the water from the diversion dam over into the adjacent valley. The material from this point was excavated with a shovel with ¾-yd. bucket loading into dump wagons. For the low portions of the dike the material was taken out of the reservoir by means of slip scrapers (see borrow pit No. 3, Fig. 3). The material for the higher portion of the dike was obtained from borrow pit No. 2 (Fig. 3). This material was excavated with a steam shovel with a 1½ yd. bucket loading into dump wagons. As this dam was of a moderate height through to its entire length very little settlement had occurred. In the case of all three dams the material was put in from 6 to 12-in. layers.

Analysis of Costs.—The following table shows the price bid per cubic yard for earth on each of the dams, and the average cost of labor and for teams during their construction:

	Year built.	Cu. yd.	Price bid	Average labor price per hr.	Average team and man price per hr.
Le Roy Dam	1915	25,000	$0.40	$0.20	$0.50
Johnstown Dam	1918-1919	50,000	.75	.40	.80
Newark Dam	1919	35,000	1.00	.45	.80

Note: 10-hour day in each case.

What an Annual Report of a City Should Contain

An annual report is an essential part of the year's work of any city administration. City officials should not regard the making of the annual report as a mere "piece of red tape required by law." Almost any kind of an annual report will meet the requirements of the law. But the annual report which achieves the object for which the law was framed does much more than merely satisfy the letter of the law. How this may be accomplished is set forth as follows in Kansas Municipalities.

The primary object of an annual report is to acquaint the taxpayer with the management of his government. As the stockholders of the municipal corporation, the taxpayers are entitled to a report of the year's work of the corporation.

Must be Readable.—But this report must be in a readable and understandable form. Taxpayers are human. They are usually too busy making a living to have time to solve statistical puzzles and masses of abstract figures. Therefore, the annual report should be simplified, illustrated, analyzed, and visualized. The sewer extensions, the tax rate, the cost of the services of the big policeman on the street corner, are all matters which can be boiled down into chart form, and presented to the taxpayers in the shape of graphic pictures. He can thus digest the significance of a mass of uninteresting facts and figures at a glance.

That an annual report is almost meaningless unless it is accompanied by comparisons with previous annual records should not be overlooked. A report should be cumulative. Here again is an excellent opportunity for chart work.

Importance of Pictures.—In order to present the work of the city and the city departments in a complete form, an annual report must contain good, clear photographs of the city's achievements in the way of additions to its equipment for carrying on business. Why shouldn't a report show the taxpayers the mud puddle that was transformed into a paved street? The picture of the new fire truck would not only be interesting in itself, but it would arouse an interest in the reader as to the cost of the truck, the reasons for its purchase, the expected saving and increased service.

Style and Form.—A city's annual report should be neat in form and a fit representation of the standing of the city government. It should not, of course, be unduly expensive. It should conform, so far as possible, with the rules of good style and modern principles of publicity. Tho local newspaper men and printers are in a position to give the city officials many good pointers in the matter of the form and style of the report, and they are, as a rule, glad to advise with them.

No report should fail to give a statement of plans for the next year. What work, in the opinion of the city officials, should be undertaken by the city during the ensuing year, and the gist of their recommendations for carrying out this work, are necessary items of the complete annual report.

Circulation of Report.—Given a readable report, it must be placed at the disposal of the taxpayer. He is entitled to a copy delivered, by special messenger if necessary.

A sufficient number of copies should be printed to place one in the hands of every taxpayer, and have a sufficient number for exchange purposes and for permanent records.

It is an excellent policy to exchange annual reports with other cities. The knowledge of what neighboring municipalities are doing is an invaluable and indispensable asset. A willingness to exchange annual reports is an evidence of a spirit of co-operation and progressiveness.

The postage required to mail out the report is a part of the expense and should be provided for in the beginning. The city that is reluctant to exchange reports, and to prepay postage on its own report lacks a progressive spirit, and falls far short in the matter of modern business courtesy.

Should be a Good Advertisement.—An annual report should be looked upon as advertising matter for the city in a certain sense. It should be the sort of a record that the local chamber of commerce would be glad to send to a prospective citizen seeking information about the town. But the facts should never be misrepresented. A well prepared annual report unconsciously and inevitably becomes a good advertisement for a city. For a successful annual report is nothing more or less than a true story told in the most attractive way.

No group of city officials should consider their year's work completed and their duty performed without the publication of a creditable annual report.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Pumps—Traylor Engineering & Manufacturing Co., Allentown, Pa. A bulletin illustrating and describing the new power pump brought out by this company.

Swimming Pool Sanitation—Wallace & Tiernan Co., Inc., New York City. A 30 page technical publication describing the use of chlorine for sterilizing swimming pool water.

Hydraulic Rams—Rifle Engine Co., 142 Cedar St., New York 12 page circular describing the use of the rifle ram for furnishing water supply for the farm and country home.

Meter Boxes—H. W. Clark Co., Mattoon, Ill. 24 page bulletin illustrating and describing the many types of Clark meter boxes adapted to all of the southern states and made to fit every special locality and condition.

Wood Pipe—Western Wood Pipe Publicity Bureau, Seattle, Wash., 40 page bulletin illustrating and describing types, sizes and characteristics of wood pipe installations for power, irrigation, mining, municipal and other uses.

Steel Overshoot Water Wheels—Fitz Water Wheel Co., Hanover, Pa. 80 page booklet devoted to the Fitz steel overshoot water wheel. Contains drawirgs of interesting illustrations and of general information on the use of these wheels.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.
Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., AUGUST 18, 1920. Number 7.

The Wage Increase of Railway Employes in General and of Engineers in Particular

The wages of the 1,900,000 railway employes have just been increased about 22 per cent, or a total of $600,000,000 annually, thus bringing the railway annual payroll up to $3,500,000,000. The average employe will receive about $1,750 a year, as compared with $810 in 1914, or an increase of 115 per cent.

A table of wages for each of the 60 classes of railway employes is given on another page. The average wage before the increase was about $119 a month, and now it is about $146 a month. It will be noted that the average wage of the 10,000 assistant engineers and draftsmen was $139, and has been increased to $170; hence the engineering force, taken as a whole, now receives an average wage that is less than a dollar a day in excess of the average paid to the 1,900,000 railway employes!

It has been stated recently that many railway officials are worried over the reluctance with which civil engineering graduates enter the employ of railways. This reluctance will not decrease until railway companies increase the average salaries of their professional engineering force until it at least equals the average salary of their locomotive firemen.

Rates of wages, like the prices of commodities, are determined by supply and demand. Hence, it has been argued engineers must expect low wages if the market is glutted with engineers. But this reasoning leaves out of account the fact that there are engineers and engineers. The most ambitious, energetic and quick-witted of the young engineers will always refuse to stay long where salaries are low. They will migrate to better fields. It will continue to be possible to fill the places of ambitious young engineers with men who are not so ambitious. The law of supply and demand will hold, but not to the advantage of a railway company that persists long in ignoring another law, namely, that the ablest young men gravitate toward the places that yield the greatest income.

The Alleged Safety of Airplane Transportation

Percentage figures as to accidents mean little or nothing to the average person until the percentage in one class of risk is compared with that in another. A great deal of erroneous reasoning springs from failure to make such comparisons. Thus we are told that civil travel by airplane is not very dangerous because during the last 8 months of 1919 only 6 passengers were killed for 100,000 hours of airplane flight in Great Britain. Yet, if the same percentage of deaths had occurred among the railway passengers of Great Britain there would have been 105,000 fatalities in the same 8 months, as contrasted with about 100 actually killed. In other words, air travel in Great Britain during the year 1919 was about a thousand times as fatal as railroad travel, as far as passengers were concerned!

Turning to the fatality among pilots of airplanes we find it to have been eight times as bad as among the passengers carried. There were 18 pilots killed and 72 injured per 100,000 hours of airplane flight. There are about 30,000 locomotive drivers in Great Britain. If we estimate only 1,000 hours of actual travel per year for each of the 30,000, we have a total of 30,000,000 hours of travel for these enginemen. The fatalities among them are about 20 a year, or one fatality per 1,500,000 hours of travel as compared with one fatality per 2,000 hours of travel of pilots of airplanes.

Commenting on this subject, The Engineer of London, says:

> The position revealed by our figures cannot be regarded as cheerful. We would instead describe it as very depressing were it not for one reflection: civil aviation has been conducted so far on such a small scale compared with railway transport that extrapolation of the casualty statistics may involve the well-known possibility of arriving at a misleading result associated with the process. We are not entitled to assume that the dangers

of flying as revealed by the casualty statistics for the small amount of civil aviation so far attempted would of necessity be confirmed were the services greatly expanded. Thus, while a greatly extended system of aerial transport would conceivably be accompanied by the introduction of dangers which are today not present, or are insignificant—for example, the risk of collision in the air—equally conceivably would the extension reduce some of the existing risks such as those involved in the dependence upon a very limited number of machines and pilots. Nevertheless, the comparison we have instituted is, we think, sufficiently sound to serve as a check upon those who would make wide claims for the safety of modern flight. No doubt, as compared with the early days, such safety has been increased to a remarkable extent, but it would be foolish and, in the end, harmful to encourage the belief that practically all elements of danger have now been eliminated. Compared with travel by rail the dangers of flight are demonstrably still of very formidable magnitude, and until they have been reduced any reduction in the cost of aerial transport—greatly as it is required—will inevitably fail to increase the popularity of civil aviation.

How Can the Drift Toward Municipal and Federal Ownership of Utilities Be Stopped?

The belligerent attitude of the public toward railways and other public utility companies is ascribable mainly to ignorance. This ignorance unfortunately has been almost as great among newspaper editors and reporters as among their readers; so that we have had altogether too many examples of the ignorant expounding their ignorance to the ignorant. As an instance, we may cite a recent article in the Chicago Tribune by Oscar E. Hewitt, a space writer.

Mr. Hewitt finds that of a total plant "value" of $158,500,000 for the surface traction lines, about $10,700,000 is invested in pavements. Since an 8-ct. car fare is expected to yield net earnings of 6.84 per cent on the total "value" Mr. Hewitt estimates that the car riders must pay about $733,000 annually for "interest on paving." He says:

> Each year, as paving has been laid, the cost thereof has been added to the capital account and patrons of the line have been forced to pay dividends on each addition.
>
> The car riders must also pay for the paving—the $10,723,898. The money is technically supplied by the company, but it actually comes from the pockets of the car riders.
>
> The company, when it needs money in normal times, sells bonds or notes. These must be paid out of the car fares. The interest also comes out of the car patrons. When the principal and interest have been paid by the car riders, then the company will keep on charging dividends against the value of the money spent to get the pavements. That sum is in the capital account.

Mr. Hewitt is so ignorant of accounting and finance that he arrives at a wholly false conclusion when he says that the car riders pay not only the interest on the pavement cost but the first cost of the pavement as well. How he made such a blunder is not easy to understand, except on the theory that a man ignorant of a given subject is likely to err even when error seems impossible to one who has knowledge of the subject. Note the naive statement that when a street railway company sells bonds or notes it recoups itself therefor out of the income from car fares! If this is so, why does Mr. Hewitt limit his denunciation of the company to its practice relative to pavement charges? The very same practice must necessarily apply to the rest of its investment and therefore the car rider must have supplied the money with which to build the entire plant!

It has long been contended by street car companies that they should not be required to furnish the capital for paving between their tracks, not only because an unnecessary burden is placed upon the companies but upon their patrons. The companies find it difficult enough to sell stocks and bonds for their own necessary improvements, without being compelled also to finance street improvements. The street car riders, it is held, should not be required to pay interest on street paving, as they do when a street car company pays for the pavement. But all this is entirely different from the statement that Mr. Hewitt makes to the effect that "The money (for pavements) is technically supplied by the company, but it actually comes from the pockets of the car riders." The fact is that rarely does a dollar of any public utility investment, whether in paving or in any other plant account, "come from the pockets of the car riders." It is true that frequently a public utility company invests part or all of its surplus or depreciation reserves in its plant, but when this is done it is not the money of the patrons that is so invested but that of the stockholders. In the case of the Chicago traction lines, surplus and reserves have long ago almost vanished, so that this factor need not be considered in any attempt to palliate Mr. Hewitt's blunder.

When so ably edited and so fair a newspaper as the Chicago Tribune, "The World's Greatest Paper," publishes such grossly misleading articles as the one above quoted, is it to be wondered that so many American street railway companies have become nearly bankrupt? Yet it is not only what newspapers print but what they fail to print that accounts largely for the antagonistic attitude of the public toward the utility companies. When a state public utility commission raises the rates of a utility company rarely does a daily paper comment favorably upon the act. By failure to voice approval of a just ruling of a commission, newspapers give the impression that they do not regard the ruling as being just.

This combination of ignorant reporting and silent editing of utility affairs is rapidly leading the country toward municipal ownership of street railways and other public utilities, for it is driving capital away from the utility field. Ten years more of such newspaper conduct will put an end to private ownership, and therefore to rapid progress in the traction field. It is to be hoped that chambers of commerce, professional societies and all the organizations of thinking men who have public welfare at heart, will take an active part in leading the daily newspapers to report and discuss public utility rate matters correctly and with intelligent discrimination.

Some utility companies conduct advertising campaigns to win public support, but usually these campaigns are weak on data and strong on assertion. Moreover they lack editorial support. Editorial support must be secured for utility companies and for state commission regulation of rates, if public ownership is to be prevented.

Improving Freight Transportation

Freight car mileage attained its maximum in 1916 when it averaged 26.9 miles per car per day. Freight car loading attained its maximum in 1919 when it averaged 29.1 tons per loaded car. But since 1916 the daily car mileage has steadily decreased, being 26.1 miles for 1917, 24.9 for 1918 and 23.1 for 1919. In short there was a decrease of nearly 21 per cent in the daily car mileage during those three years. On the other hand, car loading increased from 22.4 tons in 1916 to 29.1 tons in 1919, or more than 30 per cent. Hence if the daily car mileage is brought back to the average for 1916, it will be posible to transport about 30 per cent more freight than was hauled in 1919, without increasing the number of cars.

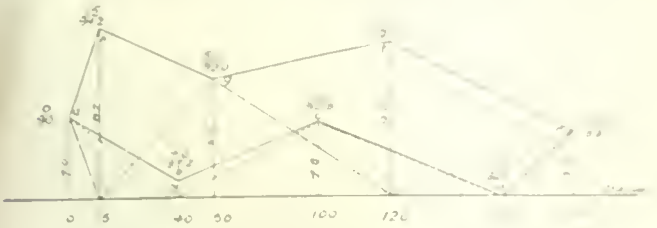
Daniel Willard is authority for the statement that 30 miles per car per day can be readily attained and maintained. If so, there is little reason for the prevalent pessimism about the freight car situation. The fundamental trouble is not from lack of cars but from failure to keep them moving. Both the railways and the Interstate Commerce Commission will doubtless adopt drastic measures to reduce delays in loading and unloading cars, as well as delays incident to congestion at terminals.

About 7.5 per cent of all freight cars are in "bad order," or a total of 180,000. It is practicable to reduce this number by 50 per cent, thus increasing the useful supply of cars by 90,000.

A. A. E. Passes 20,000 Mark.—The American Association of Engineers on July 27 passed the 20,000 membership mark. The association was organized in 1915. At the beginning of 1919 it had about 2,500 members. At the beginning of 1920 it had 10,450 members. The growth in 1919 was 8,150 members; that in the first seven months of 1920 was 9,550. In other words, the association is growing about twice as fast this year as in 1919. Since the first of the year 1919, the number of local chapters and clubs of the association has increased from 26 to 209. The national characteristics of the organization are fully borne out by the distribution of these local groups in almost every state in the Union.

Computation of Cross Section Areas

To the Editor: The discussion that has been going on for the past few weeks as to the best way to compute cross section areas has been very interesting but to my mind there has been nothing given that has as yet equalled, let alone surpassed, the old method that was devised on the Interstate Commerce Commission several years ago. The method shown by Mr. G. T. McNabb in the July 7th issue of Engineering and Contracting comes very near to that of the I. C. C., but inasmuch as he bases his computations on a modification of the method of latitudes and departures it may be a little difficult for a computer who has had no land surveying either to follow or adopt his plan.



In the present days any office that hopes for speed or efficiency must have adding machines. With such a machine, preferably a lister, a very little practice will enable a good man to run from 10 to 15 miles of sections in one day if there are not too many plusses nor too many intermediate readings. Two men on the Federal work would compute areas, volumes, clearing, grubbing, and a few other items, classifying, collecting, totaling, and checking throughout in one day from 6 to 12 miles.

In computing any section such as Mr. McNabb has shown, a datum line must be chosen—preferably below the lowest reading—on borrow (the subgrade should be used on roadway), and then the computations made by a continuous addition of areas of triangles. In the figure Mr. McNabb used (see page 4 of your issue of July 7th) the logical datum is 86.0. Using a "lister" machine we have, beginning at the zero end on the bottom row:

4.8 x 35 = 168.0
1.2 x 100 = 120.0
4.8 x 135 = 648.0
3.0 x 25 = 75.0

Total ... 1003.0 Now clear the machine and throw in the complement 99998997.0 and start on the top row.

4.0 x 15 = 60.0
8.2 x 50 = 410.0
6.0 x 105 = 630.0
9.0 x 150 = 1,350.0
3.0 x 80 = 240.0

Total ... 1687.0 Divide by 2 gives 843.5 sq. ft.

You will note that this uses much smaller figures than those needed in Mr. McNabb's computations, which also adds somewhat to the speed on a day's run.

The following sketch shows just how these triangles are determined. The light dotted lines give the first computations or the "Take Off" while the dashed lines show the total areas, the difference being the net area required. It will at once be noted that as the computations are made by using the vertical elevation above or below a given datum at each station, the most logical datum to use on roadway work is the sub-grade elevation as shown on the profile, and the cut or fill as referred to this line is at each point the elevation of the triangle to be computed, while the base is equal to the horizontal distance between the points. On all the intermediate readings, as b c d, the distances between the two points adjacent (b-d) are used with the height at (c), thus computing two triangles at each operation.

On borrow a good selection of the datum line may save at least one computation, as the point (d) falling on the line gives one set of "Take Off" triangles as straight lines and no area. With a little care and study this method can be used on any shaped figure—cut or fill. In fact, the writer, while by no means originating the method, has used it in computing sections where there was originally an overhanging bluff and in some cases where overhanging ledges were still in place. I feel safe in saying that there is no case where this will not prove absolutely accurate, and more speedy than the old methods of computing, or plotting and planimetering, while in the great majority of cases its only speed limitation is the number of times that the registering action of a listing machine can be worked.

One great advantage of this system is the many safe short cuts that soon become familiar to the computer. For example, in the above computation a skilled man would change the 4.0 x 10 to 4.0 x 25 and omit the 7.0 x 75 in his "Take Off" area, and in his total area he would omit the 4.0 x 15 and change his 3.0 x 80 to 3.0 x 55, thus reducing his operations about 20 per cent by not computing the end triangles. This particular saving would occur in the great bulk of end areas, and many other omissions and short cuts would continue to develop.

Pine Bluff, Ark.

B. P. ROSECRANS.

Allowance for Excess of Cut Over Fill in Earthwork

To the Editor: There always has been more or less discussion concerning the amount of excess of cut-over fill allowed in earth excavation and embankment work, and any attempt to set down definite figures for the amounts to be allowed usually meets with adverse criticism. Knowing the foregoing to be true, the writer nevertheless submits a chart which he believes comes reasonably close to meeting the requirements of highway engineering, and which, if followed as a guide, would lead to results conformable to good judgment and practice. It is not presented with the idea that one should adhere blindly to the quantities shown by points on the curve, but should be guided by the changes in percentages allowed with the changes in amount of excavation.

The curve itself was determined by a study of existing road sections actually constructed, and which had been figured to allow for an excess of cut-over fill conforming to the points on the abscissa. Only those cases were considered which had proven to be well constructed, the cuts and fills as made being materially as shown on the plans.

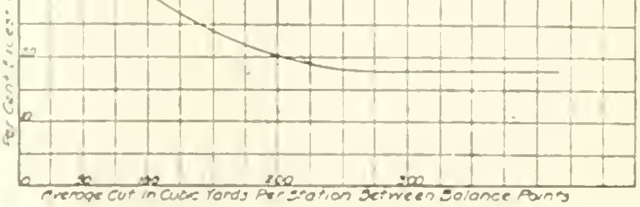


Chart Showing the Relation Between Amount of Excavation and Excess Overfill.

Some may doubt seriously the advisability of allowing as large a percentage as 40, but the writer knows personally of many instances where 25 and 36 per cent have proven entirely inadequate. This is especially true in very light excavations, and where the haul is from 300 to 500 ft. It may be difficult to figure where the dirt goes to, but it does go somewhere, and seemingly does no good in making a fill. This loss will be noticed most in the case where the new road passes through a field and the ground is soft and loose.

The percentages allowed for heavy work are much lower.

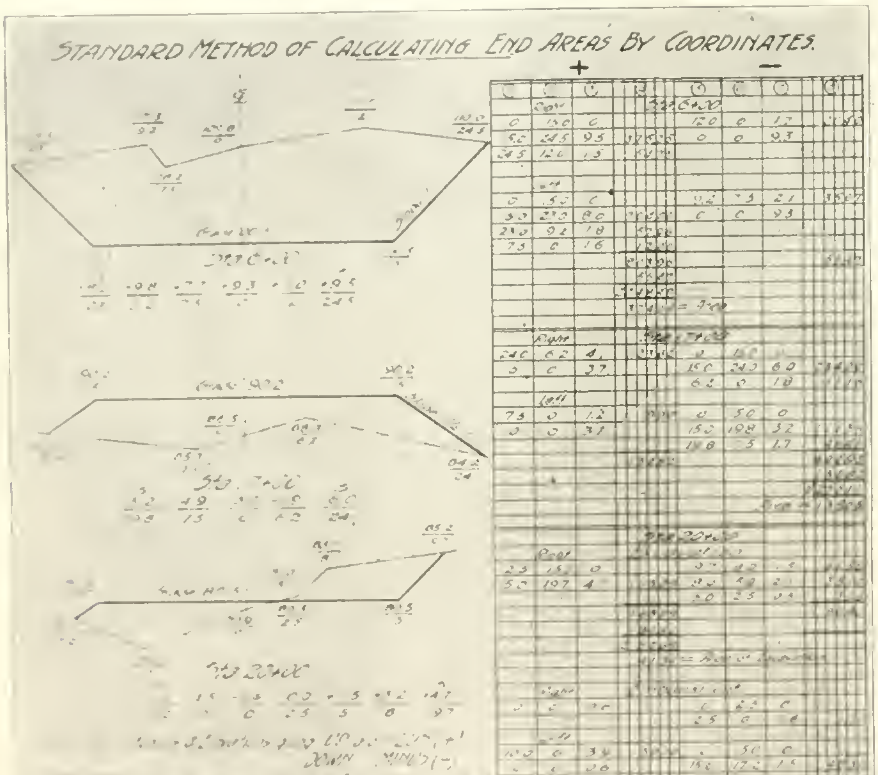
The reasons for this will be apparent to those who are familiar with heavy grading work.

The percentages recommended are somewhat higher than are in ordinary use, but it is believed that there are benefits which accrue to offset the difficulties in cost between section using high and low percentages of excess. Take as an example the usual road in the process of construction. The contractor makes the slab, only to find that there is not enough dirt to make the shoulders. How many times has this happened? About four times on every road section ever built. There will be many times when all the available dirt had been figured on clear to the limits of the right of way, and no more was available without long hauls or the purchase of a borrow pit site. It is a case of longsightedness to provide for just such contingencies and have you ever tried to deal with a farmer who knew you wanted the dirt badly, and who knew you had to get it from his land?

East St. Louis, Ill. W. B. WALRAVEN.

Methodof Calculating End Area by Coordinates

To the Editor: Enclosed herewith you will find a blueprint showing standard method of calculating end area by co-ordinates. It may be used wherever irregular sections are found in borrow pits, foundations, etc. This method has been in use a long time and especially by the Aqueduct Commission and the Board of Water Supply of New York City.



It is an accurate, concise and quick method to do this tedious work. DANIEL ULRICH,

Assistant Division Engineer,

Raleigh, N. C. North Carolina Highway Commission.

Stiff Hats for Protection of Miners Against Falling Rock

The use of helmets during the war has accentuated interest in the advisability of using stiff hats in mines to protect the miners against falling rocks. About 40 per cent of the accidents in mines are due to falling rocks or roof. A large number of these accidents could be prevented if the miners wore stiff hats or helmets. Some interesting information on this subject is given by Assistant Chief Mining Engineer, Bureau of Mines, C. Lorimer Colburn, in a recently issued report of investigations of the Bureau.

The use of head protective devices in mines is not new, for they have been in use for many years in Europe and in the Lake Superior District in the United States. In practically all of the mining districts in Europe stiff hats of some kind are required by the mine management. George S. Rice, Chief Mining Engineer of the Bureau of Mines, reported that in Germany, Belgium, and France stiff hats made of papier mache or felt rosin are in use. Similar hats are generally employed in the Lake Superior District. In building the subways of New York and Philadelphia it was the practice of engineers and workers to let the hair grow very long and to wear a close fitting cap or felt hat. In Germany the hats are high like the military helmets, whereas in France and Belgium they fit more closely to the crown. In England the practice is mixed. As a rule the miners use soft padded caps, but in Yorkshire many of the miners use sole leather, tight-fitting caps of jockey pattern with the seam forming a little ridge down the middle of the cap. These hats are very useful in low thin beds of coal, as in crawling one is very likely to strike his head on a sharp piece of rock or on a timber. Of course, such mishaps are more likely to occur to a man not familiar with the mine. It must be admitted such hats do not stick on well, though this is usually due to their not being especially fitted. The German hat is particularly unsuited to an American-shaped head.

It is interesting to note that on the continent tight cotton caps are generally worn over the hair and under the hard hat. This is a measure for cleanliness which is excellent. In low beds of coal where much crawling on hands and knees is necessary the dirt and coal dust sift down, making the miner black and dirty. In metal mines stiff hats are of especial use in shaft work; also in raises or high stopes. A small fragment of rock falling some distance either down a shaft or raise would kill a man if it struck him squarely on the head. A stiff hat or helmet may protect him and save his life. At a station in a shaft where men are loading the cage or skip, some kind of adequate head protector should be compulsory. A head-protecting hat or cap which is also a good insulator should be worn where there is danger of striking one's head against a wire carrying an electric current.

As a rule, Miners are more willing to take chances than to wear a cumbersome or hot device. The European miners have become so accustomed to the use of a head-protecting device that wearing one has become second nature to them. It would be desirable if stiff hats were in more general use in our mines.

Subway for Tokyo, Japan.—A charter has been granted for a subway—the first in Japan—to be constructed in Tokyo. This is part of a plan for improvments in transportation facilities in Tokyo and Osaka which will involve the expenditure of many millions of dollars.

Method of Building Concrete Tailrace Below Stone Arch Bridge Foundation Level

The building of a concrete tail race under an old stone arch, double track railroad bridge at Hamilton, O., involved some unusual construction features. The tail race was constructed for the new power plant of the Fordson Tractor works at Hamilton. The bridge, which is owned jointly by the B. & O. and the P., C., C. & St. L. R. R., has four arches. Cracks in them and a few stones which have fallen out show that the foundations have settled. The conduits were carried 12 ft. below the pier bottoms. The methods by which the work was handled are described in the July Miami Conservancy Bulletin, from which the matter following is taken.

As originally planned, the new power plant would supply about 1,000 h.p., taking the place of the old power plant of the Hamilton & Rossville Hydraulic Co., removed from a central position in the city to its northern limit in the carrying out of the flood prevention plans. When Henry Ford & Son purchased a controlling interest in the power plant, with the intention of using the power in driving their new farm tractor factory, the original capacity required to be much increased, to a full load limit of 3,300 h.p. This required such a deepening of the tail race, to take the increased water consumed, as to carry the bottom of the new structure about 12 ft. below the arch bridge foundations. With the arches in the condition described above, and with many trains on both railways passing every day, which could not be interrupted, it was necessary to exercise unusual care to keep the foundations stable, both during construction and afterwards.

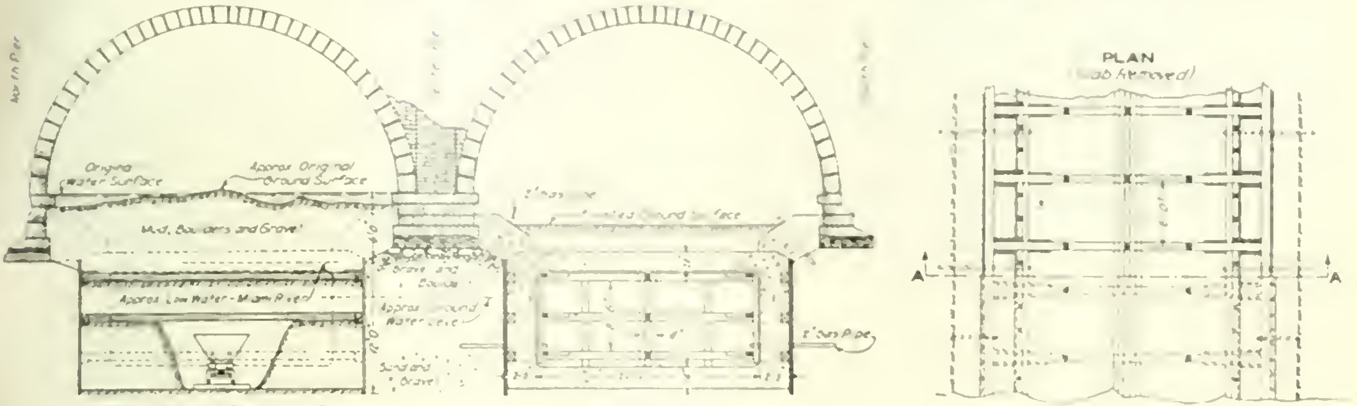


Fig. 1.—Plan and Sections of Tailrace Conduits Under B. & O. R. R. Arch Bridge at Hamilton, O.

The power plant is about 400 ft. east of the bridge, and just north of the new Fordson plant and the north protection levee of the city of Hamilton. The head race is east of the power plant. Thus water from the head race passes through the wheels on westward into the tail race, which passes under the arch bridge, thence curving northward and then southward to the river. From the power plant to the bridge the tail race is an open channel 50 ft. wide and about 100 ft. long with side walls 4.5 ft. high, the walls and floor being plain concrete. The walls are 3.5 ft. thick at the base and 1 ft. thick at the top. The floor is 6 in. thick. This concrete channel is continued for a center line distance of about 75 ft. west of the bridge, after which it continues as an open channel excavated in earth, widening gradually to 80 ft., which width is continued to the river. No construction difficulties were encountered except those connected with passing under the stone bridge.

The two center arches of the bridge are of 30 ft. span, the two side arches of 20 ft. span. It was planned to carry the tail race under the bridge in two branches, one through each of the two middle arches. Each branch would then be a rectangular conduit, 20 ft. wide by 8 ft. 6 in. high inside with side walls 2 ft. 6 in. thick, bottom 2 ft. thick and top 20 in. thick. This would leave only 2 ft. 6 in. on each side between the conduit and the arch foundations. Excavation showed that the latter were shallow, resting on timber grillages, which rested in turn on gravel. The bottoms of the grillages were about 12 ft. above the bottoms of the proposed conduits. To keep the gravel under the grillages from caving in, it was planned to drive a line of interlocking steel sheet piling on each side of the proposed excavation and as the material was dug out to introduce bracing timbers between the two rows of piling. After the excavation the conduit floor would be cast, then the side walls, using the steel piling for the outsides of the side wall forms, then the roof. The floor and roof together would then act together as braces to support the gravel beneath the bridge piers, permitting the withdrawing of the bracing timbers.

These operations constituted the main program and were carried out as described. An additional feature was introduced owing to the desire of the railway companies to provide for a future widening of the bridge to accommodate four tracks. This would mean the extention of the concrete conduits and a partial filling in with earth of the space beneath the arches. The conduit roof as first planned would not provide sufficient strength to support this earth material. To meet this contingency, a center wall was introduced into the design, 18 in. thick. This wall was poured after the roof, through holes left in the latter 12 ft. apart, and of course after the removal of the brace timbers. An additional factor of safety in the design, a concrete coping was then poured, connecting the conduit roof to the bottom of the stone arch on each side. These features are shown in Fig. 1.

Finally, the plan provided for the forcing of cement grout, under pressure, into the gravel beneath the bridge piers. This grout was introduced through gas pipes cast into the side walls of the conduits, at the bottom, 12 ft. apart. Similar pipes were cast into the copings connecting the conduit roofs and the piers, to permit air and water to escape as the grout was forced in at the bottom.

The program for the excavation is shown in Fig. 1. The upper 6 ft. consisted of mud and gravel, with larger stones and boulders, intermixed, the latter being apparently material wasted during the construction of the arches, or placed to prevent scour. Most of this part of the excavation was done by hand and wheel barrows. On reaching the level of the top row of timbers for the sheet piling, these were laid and the piles driven. The excavation was then continued down to the level of the second row of timbers. These were then placed and the remainder of the material removed as shown in

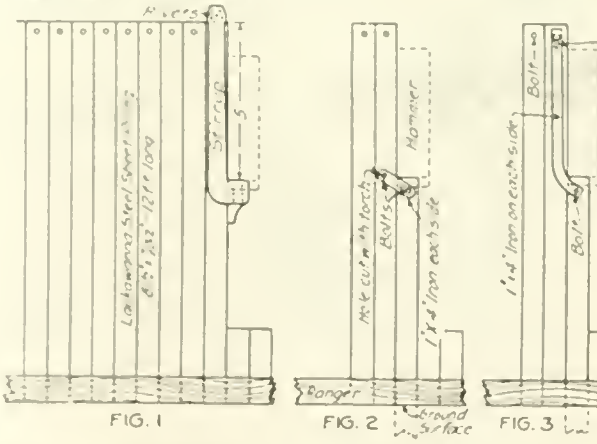


Fig. 2.—Method of Driving Sheet Piling.

Fig. 1, using a steel dump car into which the material was shoveled. Some of the material, after the upper part was removed, was taken out with slip scrapers. The excavated material was dumped in heaps outside and removed by a dragline excavator which was engaged in building the north Hamilton protection levee, the latter being located just south of the bridge. This machine also dug some holes which gave dumpage ground for material after finishing its work.

The most vexatious of the minor problems was the driving of the steel piling. The difficulty lay in the lack of room to set up the pile driver, the piles being 12 ft. long, and requiring to be driven close to the faces of the bridge piers, where the dropping of the arch surfaces toward the spring lines gave very little head room. There was just sufficient space to set up the piles, but not enough to work the hammer. To meet this difficulty a stirrup like that in Fig. 2 was hung over the top of the pile, except that it was hung with its foot at the side of the pile instead of at its edge, the pile driver hammer striking this foot. This gave so much vibration under the impact of the blow that it was quite ineffective and had to be abandoned. The stirrup of Fig. 2 was then tried, with much better results. The first one used was too light and broke across the angle next the foot. Several trials evolved the form shown, which lasted through the job.

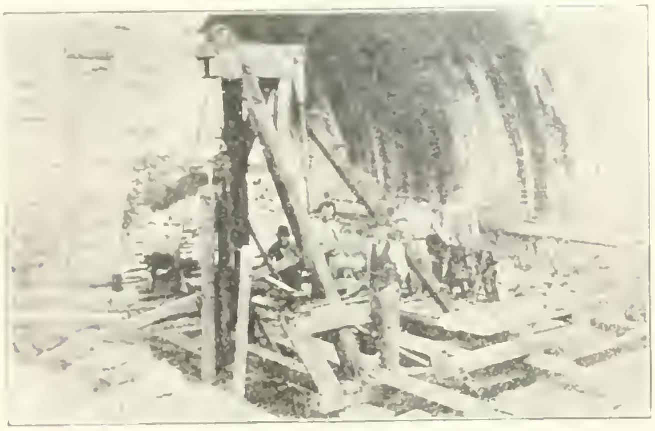


Fig. 3.—Driving Sheet Piling for Tailrace Conduit Foundations.

Driving with this stirrup, however, was found to be very slow, and other expedients were considered. The first of these was to drive each 12 ft. of piling in two lengths, one of 5 ft. and the other of 7 ft. By driving a 5 ft. on top of a 7 ft., and then a 7 ft. on top of a 5 ft., the short lengths would break joints, and present an interlocking wall 12 ft. high. The idea was abandoned, however, it being thought that the scheme would give a weakened structure, and that the joints would not be tight.

Then an attempt was made to drive a 7 ft. pile, draw it out and insert a 12 ft. in its place, driving the latter to the full depth. This scheme failed on account of the gravel falling into the hole on withdrawing the 7-ft. length.

Finally the scheme was tried of driving one pile about half way down, then attaching a second pile to the first, and driving the two as one. When the first was full down, the second would be half way. A third could then be attached to the second, and the process repeated. The attachment is shown in Fig. 2 of Fig. 2. It failed on account of the shortness of the link, this making the shear in the hole so great as to cut through the web of the pile. Lengthening the link as shown in Fig. 3 of the Fig. 2 lessened the shearing stress to the direct blow of the hammer, or nearly so, and cured the process of this weakness.

In the plan as perfected, about 9 piles were laid on the ground side by side, interlocking as if driven, and lifted by one end into an upright position next the ranger which guided and kept the piles in place during the driving. The stirrup then slipped over the first pile, which was driven 5 ft. down. Next the straps of Fig. 3 (see Fig. 2) were applied, attaching the second pile to the first, and the first driven home. Then the straps were shifted to join the second pile to the third, and the process repeated till all nine piles were driven. A second set of nine piles were then set up as before and the process repeated. This left the stirrup to be used only on every ninth pile. The number nine was adopted as being the maximum which the crew could handle conveniently.

The driving was slow, both on account of the restricted space making the expedient described necessary, and also because of the large number of boulders encountered by the piles in the driving. Sometimes hours were necessary to get down a single pile. Sometimes 16 could be put down in the 10-hour shift. In spite of the boulders the alignment at the bottom of the piles was fairly good, although a good many blocks and wedges were found necessary in lining up the lower set of rangers. The job as thus completed was quite satisfactory.

The pile driver rig is shown in Fig. 3. It was hung from a pulley carried at the top of a tripod mounted on a timber platform which ran on rollers. The hammer was lifted and lowered by a hand winch. The pulley at the top was carried by a heavy horizontal plank which slid in guides, driven by a lever, to permit setting the hammer directly on top of a pile, or beside it, as required in the experimental adjustment of the scheme for driving the piles by a stirrup, as above described.

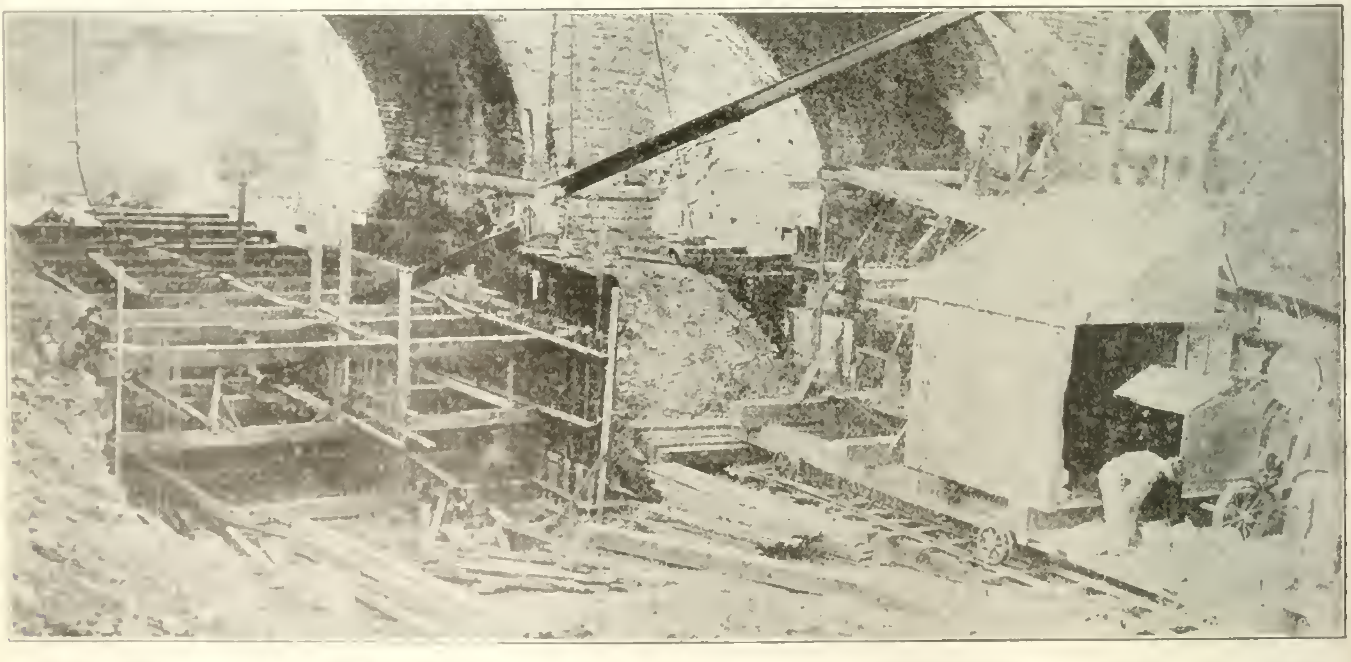


Fig. 4.—Concreting the Conduits for the Hamilton Tailrace.

Water in the excavation gave very little trouble during the progress of the work. A tailrace discharging from the old hydraulic canal formerly ran under the bridge, but this had been long out of service except to [illegible] overflow. Old River channel, a former course of the [illegible] also ran under the bridge, but it is now dry in ordinary times. Water level in the present Miami, about 1,000 ft [illegible] is in dry seasons about 6 ft above the [illegible] the new tailrace structure, and ordinarily, the soil being mostly sand and gravel, this would have given heavy [illegible]. Fortunately, however, the Hamilton water works take their supply from drilled wells in the gravel, only a short distance from the bridge. These pumps, in the regular course of their duty, did most of the work of keeping the excavation dry, drawing down the general ground water level. There was, of course, some seepage, which was removed at first with steam jets. These, however, gave too small discharge and were replaced by a centrifugal steam pump. This gave trouble from excessive vibration and running normally at constant speed, it tended to pump the excavation dry, and require frequent repriming. A Worthington duplex pump was the final solution of these troubles, and proved very satisfactory. Steam was obtained from the B. & O. R. R. pumping station near by.

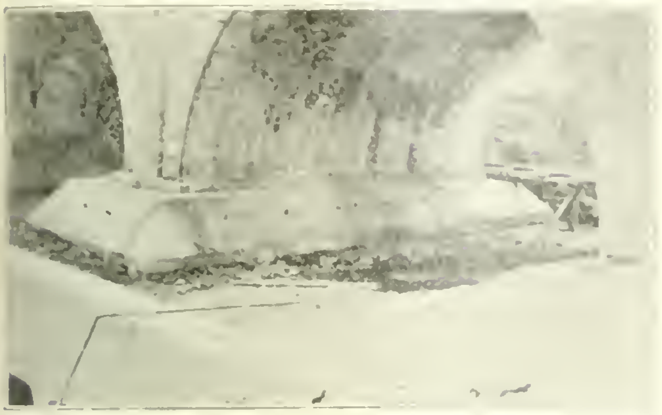


Fig. 5.—Concrete Reinforcing Bridge Pier.

The portion of the tailrace under the bridge was integral with the remainder, and the concreting in both cases was done under contract by the F. K. Vaughn Building Co., the same firm who built the Fordson Tractor plant adjoining. The concreting plant used was the same throughout, and consisted of a mixer and tower on a platform running on rails as shown in Fig. 4. In building the twin conduits, the floors were poured first in about 15-ft. sections. The forms for the side walls and the roof slabs were then built, and these concreted. The forms were then set for the portions of the structure which embrace the bridge piers, and connect the latter with the conduits. (See Fig. 5). The forms for the center walls through the conduits were built, and these walls poured, after the removal of the side wall and roof-slab forms, the concrete being passed through 6 in. by 12 in. holes spaced 12 ft. center to center, which had been left in the roof. The brace timbers crossing the excavation from pier to pier were boxed in, where they passed through the side wall forms, and not removed until after the side walls, floor and roof were cast; following which the boxes were knocked out and the holes they left in the side walls filled with concrete.

As a final precaution against any possible weakening of the bridge foundations by the work of building the conduits, provision was made at the request of the railroad company for grouting any possible vacant spaces in the gravel under the bridge piers with liquid cement grout. This was accomplished by casting 2 in. gas pipes into the side walls of the conduits at the bottom, 12 ft. center to center, extending through under the bridge piers as shown in Fig. 1. The free ends of these pipes were then connected to a compressed air tank, the lower part of which was filled with the fresh grout. On admitting the compressed air to the tank the grout was forced through the pipes into the gravel under the foundations. Similar gas pipes were cast into the wall coping which embraces the bridge piers, the pipes connecting with the space immediately below these piers. Air and water in this space, rising under the pressure of the entering grout below, would thus find vent.

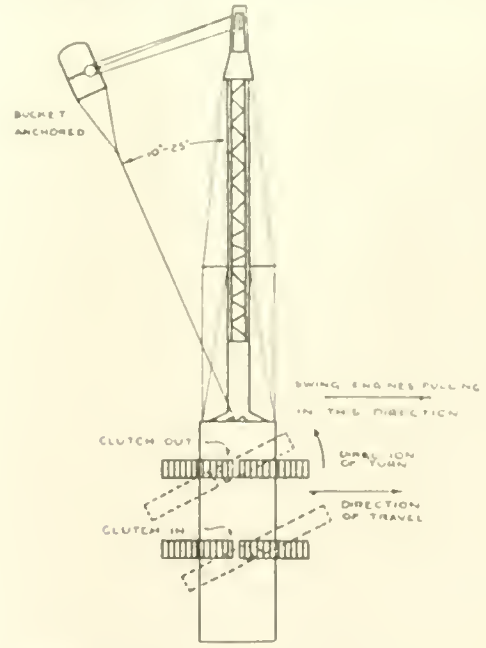
With the methods of construction employed, the care which was used in carrying them out, and the behavior of the bridge piers during the work, it is believed by the engineers who were in charge that the bridge foundations, so far from being weakened by the building of the conduits, have been materially strengthened and improved by them. There was no caving of the gravel beneath the piers during the work. No visible cracks or seams opened in the stone work. Moreover, the concrete coping which embraces the original piers, shown in Fig. 5, acts as a buttress to the bases of the piers involved, transmitting any thrust directly to the concrete of the conduit, and also acts to protect the gravel under the piers against wash from water during floods, which might pass over the conduit roof and beneath the arch. It was fortunate also, as regards the possibility of undermining, that very little sand was encountered in the process of the excavation which showed any tendency to run. Considerable seams of running sand might have given some trouble, but none of any consequence was encountered.

The work was carried out under the supervision of C. H. Eiffert, Division Engineer; R. B. McWhorter, Assistant Division Engineer, and W. T. Raine, Superintendent of Construction of the Miami Conservancy District. It was under the general supervision of J. H. Kimball, Construction Engineer, in charge of all the Conservancy work of river improvement. The inspector was G. W. Schrader.

How to Slue a Caterpillar-Mounted Dragline

A useful method employed by C. J. De Frees, a contractor of Worthington, Ind., for sluicing his Bucyrus Class 14 caterpillar mounted drag line is described in a recent issue of the Excavating Engineer.

The caterpillar clutch is first thrown out in the manner usually employed in turning. Next swing 100° to 115° from the direction in which the dragline was moving, swinging towards the direction in which it is desired to move. Then throw out bucket anchoring it firmly in the ground. After pulling in tight on the dragline, set the brake on the dragline drum. The boom is then swung back 10° to 25° as the case may be to a position 90° from the direction of travel. Then set the brake on the hoist drum and hold the strain of the swinging engines away from the direction of turn. When the propelling clutch is thrown in, in the usual manner, this strain will cause the machine to slue in the desired direction.



Sketch Showing How Dragline Is Moved.

Mr. De Frees states that he has turned his dragline by this method 50° in 3 ft.

This manner of turning will prove very useful in many instances, but good judgment must be used by the operator not to throw in too much power on his swinging engines or he will cause the hoisting line to jump the point of the boom sheave and perhaps do a little damage thereby.

How the Engineer Can Advance Himself in Railway Service*

By J. R. LEIGHTY,
Assistant Chief Engineer, Missouri Pacific Ry

There are four fundamental activities in every business; production, marketing, financing and accounting.

While the railroad business today is highly specialized and is somewhat different in its details from most other lines, still the fundamental classification is applicable to it.

The question is this: Where does the engineer fit into the scheme of organization carrying on the railroad business? In a broad sense the engineer in the railroad organization is the custodian of the physical property.

A few years ago the principal work of the railroad engineer was in connection with the promotion, location and construction of railroads. However, since in the United States the railroad development has reached the point where practically all communities are served, the work of the engineer has changed until at present it has principally to do with the maintenance and development of established systems. He is concerned principally with the matter of production and accounting, his particular interest being to maintain the properties so that whatever use is made of them transportation is produced at the lowest possible ultimate cost.

This may or may not mean the lowest possible cost of maintenance, because it is absolutely true that maintenance may be so cheap that production of transportation is expensive.

Wide Range of Engineer's Responsibility in Railroad Organization.—The development phase of the engineer's work also has to do with production, although here he touches directly upon the other three of the fundamental activities, marketing, financing and accounting, because the further development of any particular railroad property may be made for one of two reasons: First, to lessen the cost of producing transportation; second, to increase the amount of transportation which may be sold. In any event, the development of a property means, in practically every case, increasing the investment, and the engineer's work immediately begins to touch the financing and accounting features of the business.

Since the wide range of the engineer's responsibility in a railroad organization brings him into direct contact with the sub-divisions under the four fundamental activities suggested, it necessarily follows that in order to do his work with the greatest efficiency he must have considerable knowledge of the activities of all of the other branches of the business; and his value and efficiency as an engineer is very largely measured by the amount and accuracy of this knowledge, which means that he must be in close touch with every department and branch of the entire business; more particularly with the activities which, on the railroad, are called operation.

How Engineer Can Be of Greatest Value.—In order to be of the greatest value it is manifest that the engineer should be always in advance of present necessities, which means that he must be able to recognize from present tendencies what will probably be the demands of the future, and by a proper correlation of them guide the development of the property so that the things which are done today will not have to be undone in the future. These remarks have to do with the engineers as a class. I assume that what you are particularly interested in is the engineer as an individual, which means the same thing because the engineers as a class are simply the composite of the engineers as individuals.

The engineer as an individual can be one of two kinds. He may be of the type that does conscientiously and well what is brought to him to do, or he may be of the type to initiate, suggest and advise with those in higher responsibility, and I wish to say right here that in my own experience, covering almost 30 years, I have never yet attempted to do this and met with rebuff or anything but courtesy. I do not mean that anything more than a small fraction of the suggestions I have made have ever materialized, but what I do mean to say is that those to whom I have been responsible have always received in the most kindly way any constructive suggestions that I have offered. Many times I have been "shown up," so that I have enjoyed a laugh with my superior about my suggestion, but I have never yet been laughed at.

The Present Job Only One Factor in Road to Advancement.—A great many men think they have found a quick and easy road to success by concentrating on jobs they happen to hold. This is only one factor on the road to advancement, because large successes are always built upon a clear understanding of basic principles. It is entirely possible, especially for a young man, to confine his thought and studies to his own specialty to such an extent as to lose sense of the importance of a broad, well balanced training. You are not fair to yourself or to your employer if you do not understand the full import and the proper relation of the particular thing you are doing to the railroad business as a whole.

There is always a danger of half-way success. Most men possess native ability sufficient to carry them into bigger positions than they now occupy. Chief among the characteristics that carry men past the half-way mark on the road to success is eagerness to learn more about business principles and business methods. The tendency in large business organizations is to repress initiative and constructive thinking, except upon the part of a few men who direct affairs, but the exercise of initiation in spite of this tendency will be of benefit not only to yourself but to your organization.

To Enlarge Your Influence, Enlarge Yourself.—It makes no difference how great or small a man's position may be, the only way to enlarge his influence and his income is to first enlarge himself. Any of you can know more about some one thing than any one else in the organization, and having acquired that, you are only ready to know more about some other one thing than any one else. This may seem like a slow process and a futile one, but having acquired this superknowledge you may rest assured that you will be able to use it, both to your own advantage and that of your employer.

In this connection I am constrained to offer criticism with reference to the work of many who wish to be called engineers. Those of you whose duties require decisions based upon information given by others must have realized how few there are who can make a report upon a situation in such a way that you are able to fully comprehend the proposition, and how glad you are to recommend for promotion any individual who is able to put matters before you so that you can give them complete consideration without the annoyance of having to ask for more information.

It is well to adopt the principle, when making a report, that the party who is to use it knows nothing whatever about the situation, except that which is contained in your report.

Importance of Planning and Reading.—It is not the dramatic moments of life that count; it is the quiet planning and reading of the man who is getting ready now for what is going to happen, 2, 5 or 10 years from now. To elaborate the idea I have just suggested, each of you now, or sometime in the future if you advance, will have use for the knowledge of the fundamental principles of

Economics of business
Organization and control
Accounting principles and auditing
Cost finding
Corporation finances
Railway traffic
Financial and business statements
Investment
The relation between business and government.

This information, properly digested and stored away, will sometime be the bridge by which you cross over from the realm of a technician to that of an executive.

In every large organization there are two responsible groups. No matter how they are designated, they correspond to what, in the army organization, is known as staff and line; the one group formulating plans and policies, the other executing them. Every person, by reason of inherent peculiarities, is best fitted for one or the other. If you could discover for which group nature has best equipped you it might save time and disappointment, but if you are broadly prepared you will eventually find your place in one or the other groups.

Danger of Too Much Detail.—I presume some of you are saying to yourselves that you do not have time to keep up with the work imposed upon you by your present positions and have not the leisure to accomplish what I have suggested. The secret of leisure is not to do less work, but to organize so that a greater volume can be done in less time. No active man should wish to cut down his productive effort. Being swamped with too much detail is in itself a sort of business disease and a very dangerous one. As a matter of fact it is unnecessary for any man to be so swamped with details except as a temporary condition, that he cannot give a reasonable amount of time to recreation, reading and thought. Unless one can shake off the disease he will probably go on eating away more and more of his time and energy until he loses his grip on affairs and too late he sees other men rising above him.

---

*An address before the American Association of Engineers.

It is as bad for a man to be too busy as for him not to be busy enough. A man can organize his time on very much the same plan as he can organize a factory. When he does so, he invariably finds that his efficiency is increased, his work is more productive and he himself has more leisure.

In this connection we must consider the man who thinks he is much busier than he really is. There are spare moments in every man's day. How about the half hour before or after the evening meal, the time spent in traveling to and from work, the one or two evenings a week that even the busiest man can devote to his own advancement? The measure of a man's chance for success may readily be taken by learning the manner in which he uses or wastes his spare time.

There are just two factors that determine a man's competence to direct the work of other men, his superior knowledge of the work in hand and his ability to command respect. As a matter of fact, the latter is almost wholly included in the former. The man who really knows what he is talking about always commands respect. The man who is largely bluff, no matter how magnetic and forceful his personality, is soon found out and retired in favor of the man of smaller pretensions but more knowledge.

An idea, like an egg, must be laid and marketed before it is of any value and it cannot be realized upon until it has a value.

What Are Your Chances for Advancement. Another thought which is probably running through your minds is, If I should prepare myself for advancement by making additional effort what would be my chance of advancement? This rests very much with yourself.

Assuming that you are prepared and are really of more value to your employer than your present position pays, you will probably be discovered in time and advanced, but advancement will come sooner if you discover yourself.

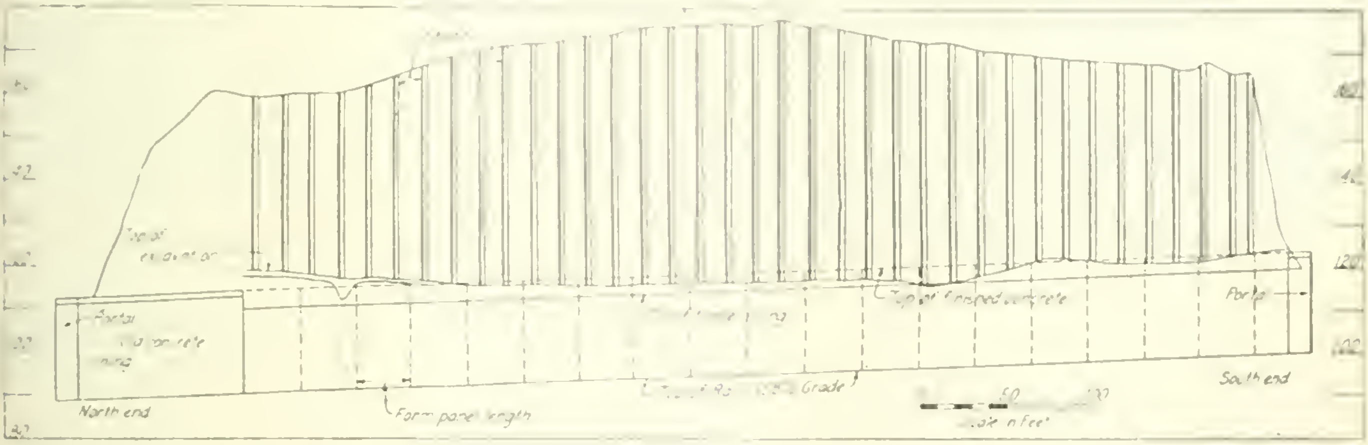
A short time ago The Saturday Evening Post carried a story entitled Selling Out in Front. The crux of this story had to do with two methods of selling—one behind the counter, showing, wrapping and handing out that which the customer came to buy; the other, in front of the counter, meeting the customer, treating him affably, suggesting to him bargains that were on the shelves in which he might be interested: the underlying idea being to benefit the customer or at least to create in his mind the impression that he was being rendered a real service for which he would gladly pay.

If you have acquired the goods and have them on your shelves it might pay to sell out in front a little.

Concrete for Lining Railroad Tunnel Poured Through 50-Ft. Drill Holes

The methods employed in the placing of 2,500 cu. yd. of concrete as lining in a tunnel of the Chicago, Burlington & Quincy R. R. near Belmont, Neb., contained several features which are of direct interest to engineers and contractors. Practically the entire work of moving the concrete materials, the forms and other equipment, etc., was performed by gravity. This was accomplished by pouring the concrete from the top of the overburden, the material being delivered to and from the mixer by means of cars on inclined tracks and in the tunnel proper by arranging the progression of all work in the downgrade direction of the roadbed. An interesting description of the work is given in the Railway Maintenance Engineer, to which we are indebted for the matter in this article.

The lining replaces an old timber lining which had become badly rotted and, in addition, gives an increased clearance to 22 ft. to conform to the present standards of the Burlington. Approximately 90 ft. at one end of the tunnel had been relined previously, leaving about 600 ft. of new work to be completed, including rebuilding the two portals. The overburden averages from 40 to 60 ft. in depth and consists of brule clay with stratifications of limestone.



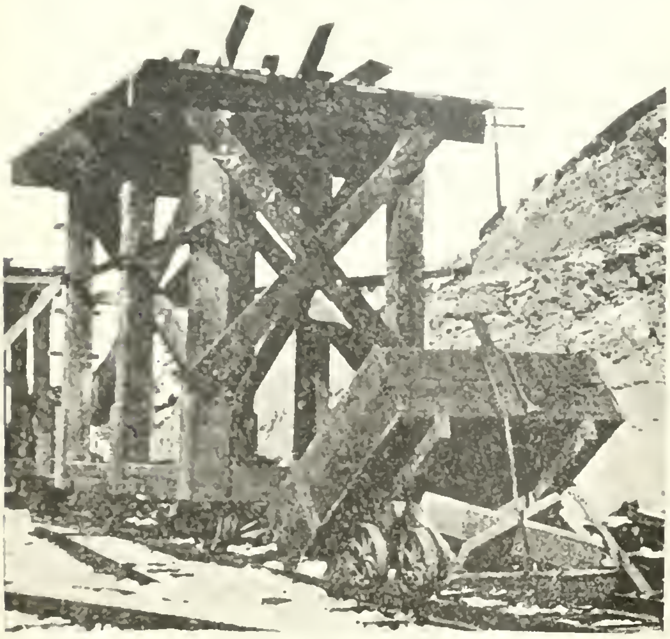
Secion Through Tunnel Showing Location of the 36 12-in. Drill Holes.

In proceeding with the construction work two spur tracks were cut in at the lower or north end of the tunnel, one leading to a storage and erecting yard for the forms, etc., and the other ending at a ravine where muck could be dumped. The old lining was then ripped out in sections by means of a cable leading to a hoisting engine located at the same end as the spur track. This hoist had the additional function of returning empty cars to the tunnel and performed such other miscellaneous work as required power. In pulling out the old lining a total of about 1,200 cu. yd. of overburden came down with the lining. This material was removed in dump cars with a capacity of 2 cu. yd., which were constructed by the contractor doing the work. When loaded they were permitted to run downgrade (the grade at this point being 1.58 per cent), the operator keeping them under control until they reached the end of the spur, the construction of this type of dump car, known as the Swedish dump car, being such that one man is able to handle them and dump them without assistance from others.

The remaining portion of the overburden, about 1,200 to 1,500 cu. yd., was chiefly of limestone and brule clay formation and had to be removed by drilling and blasting, the softer portion being removed by hand labor and picks. To facilitate this work special platforms were constructed and mounted on old car axles and wheels, permitting them to be moved in and out of the tunnel quickly to meet traffic conditions.

The mixing plant, which was located on the crest of the overburden, consisted of a 1-cu. yd. mixer, a number of ½-cu. yd. and 1-cu. yd. dump cars and some narrow-gage track. All material necessary for mixing was hauled to the location of the mixing plant from the Belmont station by team and stored there in piles. Gravel was supplied to the mixer by two 1-cu. yd. dump cars which ran between the gravel storage pile and the mixer. This discharged directly into $\frac{1}{2}$-cu. yd. dump cars which operated on a narrow-gage track laid along the center line of the tunnel and on a downgrade in each direction from the mixer, the empties being returned by a cable operated from a hoisting engine.

In order to pour the forms from the top of the over-burden, a well-drilling machine was set up and total of 36 12-in. holes were drilled, on 16-ft. centers along the center line of the tunnel. These were then lined with 8-in and 10-in wrought pipe, the alinement of the holes resulting from the effect of the stratification of rock being such as to limit the pipes to that size. In pouring, the cars were stopped opposite the holes leading to the forms set up below in the tunnel proper and the material was discharged directly into them. Two holes were poured at the same time, the concrete being allowed to run laterally a maximum distance of 8 ft. with a minimum thickness of 1½ ft. for the tunnel lining itself. Before the concrete had set, at four equally spaced points along the tunnel, the pipes were driven through the concrete. These were then cleaned out with the removal of the forms, leaving the openings of the pipe flush with the surface of the lining and forming a permanent outlet for ventilation.


1-Man Dump Car and a Platform Car.

The forms were assembled in sections or panels 33 ft. long which were made semi-collapsible. Three of these were used, two being poured while the third was being moved to a new location, all work proceeding down grade. As each panel was finished the brace spreaders at the top of the form were released and the form sprung together by means of a series of turnbuckle-bars engaging with hooks at the tops and bottoms of the side members. The form was then allowed to drop about 8 inches to supports carried upon the frame of the platform cars. This arrangement permitted them to be moved in about 30 minutes from the time work was started until the track was clear for traffic.

Type of Form Used in Tunnel.

The placing of the concrete lining in the Belmont tunnel was done under the direction of the engineering department of the Chicago, Burlington & Quincy R. R., F. T. Darrow, assistant chief engineer of Lines West of the Missouri River, Lincoln, Neb. The construction work was done by the Chicago District of the Foundation Co.

The Executive in Engineering *

By SAMUEL M. VAUCLAIN.

President of Baldwin Locomotive Works.

What is an executive? An executive is a man who does things; a man who can see his way clearly to accomplish anything that he sees fit to undertake. Therefore we not only have executives in engineering but we have executives in banking and in commercial life. We have executives in Washington in the various branches of the Government, fully capable of looking after any question which may come up, with the fullest confidence in themselves, and therefore can be given credit for being real executives.

But executives are not always big men, because the world is full of executives. No executive can be an executive of huge dimensions unless he has an army of minor executives supporting him who believe in him and his capacity to point the way for them to follow, and each in turn exact with promptness, decision and creditableness that share of the total work which may be assigned to him or to a department which may be under him.

I do not think that I can give you any clearer idea of my conception of an executive than to say that he is one who can command. In other words, he must be able to command the support of other men. The man who undertakes to do everything himself is sure to fail. The man who is an executive decides to do as little as possible himself, and if he does that he is sure to succeed.

What an Engineer Is.—We will now turn to the engineer. What is an engineer? Is an engineer a man who plods away patiently at a drawing board to produce a design of some machine, of some engineering problem, perhaps a railway proposition or a tunnel, either through a mountain or under a river; a great bridge, a steamship, a locomotive, or even a wheelbarrow? Is he an engineer, or is he simply a draftsman? Is he a toiler? Is he a man sufficiently educated to transfer to paper the ideas of others and under instructions to produce something that will guide the average workman in its construction? I do not regard men with those qualifications as engineers.

An engineer is a man who can see things, who is constructive in his thoughts, who can impart this knowledge to others, who can work not only one man on a drawing board but 20 men at drawing boards, and who can pass his ideas to them in a manner so satisfactory that they can be easily grasped. When these details are assembled from the many draftsmen who are employed you have a great and a successful machine; you have a great or a successful proposition for building a railroad, for building a tunnel or a bridge; and on the number of men that such an engineer has got to handle depends the rapidity with which this project can be put before the people to whom it must be submitted before it can be constructed; because all engineers, such as we are, before we can do anything must have the money bags in our organization agree to find the cash to do it with. Therefore if we get the right idea of an engineer, an engineer who can not only conceive how things shall be done but can instruct assistants and subordinates clearly and thoroughly in such a manner that they can grasp his ideas and make them of record, then we can easily proceed to a short discussion of the executive in engineering.

The true executive in engineering usually is called an optimist. It is very pleasant to be called an optimist. I have been referred to for years as an [illegible]. Now I am far from an optimist. I simply believe [illegible] in myself but in the other fellow. I have confidence in the engineers of this country. I have confidence in the engineers of Europe. I believe that these engineers can do things quite as well as I can, and perhaps a little better so far as the scheming out of any particular condition may be concerned.

---

*An address delivered June 4 at the organizing conference of the Federated American Engineering Societies, Washington, D. C.

But even should they not be capable of [illegible] I feel that it is my duty to permit those men to [illegible] and see successfully produced the results of their engineering skill, of their engineering knowledge, and not to attempt to change their views by substituting views of my own which would be counted as being even as good, perhaps worse, after they have been put in actual practice.

Commercial Side of Engineering.—The executive in engineering has another thing to deal with, and that is the commercial side of engineering. To be an executive in engineering regardless of the pocketbook is a simple matter. We have had illustrations of this sort of executive ability during the two years that we were at war with Germany. Those of us who spent the entire time in Washington and who were sufficiently wise to mind their own business and do as their superior officers here—the tried and competent engineers in the Government service—had an opportunity to observe the many mistakes that were made by men who came from the private walks of life and who in a short time imagined they were executives in engineering, and that they could dictate to and advise those who had served years of apprenticeship in this particular type of engineering, and who were in the judgment of those who were willing to think so wholly competent for the demands that the nation must make upon them.

The true executive in engineering hates nothing more than he hates red tape. The man who must get through, who sees the point here and his goal yonder—if he is a true executive—knows that a straight line is the shortest distance between two points. And notwithstanding legal restrictions and Government restrictions during the war, those men, men of courage, executives in engineering, put the ball of red tape in the closet and struck the line, and we who followed, we who are here to serve and to do as we are told, here to be subordinates to these men and give them the advantage of our executive ability in the engineering entrusted to us, can testify to it, and also can testify to their greatness.

If you want to be successful in engineering, do as the shoemaker does, stick to your last, and don't attempt to do all the engineering in the world. If you are an electrical engineer, be an electrical engineer, and become an executive in electrical engineering. If you are an engineer in any other branch of industry, apply yourself to that, because, if you scatter your brains over all the various engineering problems of the country, you will spread out like a drop of water on a pane of glass and, I am afraid, never amount to very much. Concentration in engineering is just as desirable and necessary as concentration in any other business that you may engage in.

You may be an engineer, but you must be a practical engineer. You may be an executive, but you must be a practical executive. The commercial side of the engineering problem must be considered, and a man cannot be a true executive in engineering unless he gives immediate consideration to the commercial side of this problem, and that is the task that I have given most attention to.

Now, in this day, with you gentlemen more than any others in the United State, the war that is the real fighting war we have had, where we have been shooting at each other once in awhile—is over. The worst has happened. There is no cause to worry any more. But there is cause and necessity now to work more than there ever was. The whole world must be taught to work and the work that is to be done is engineering work. And we here in America must not only work as engineers and as executives—executives in engineering—but also as executives in engineering from a commercial standpoint.

The devastated countries of Europe must be rehabilitated, and we can talk about sending millions and millions and millions of dollars worth of food and supplies to the devastated sections of Europe for their relief, but that will never relieve them. They must have the engineer there. They must have the executive there to advise these people and more than that, they must have both of them there in a commercial sense. They must teach these people and show these people how to utilize those things which are in the nation to enable them themselves to go to work and by their own hands earn a livelihood, to relieve themselves from the necessity of charity, to earn their own food, to make their own clothes, to attend to their own wants in every respect. It must be accomplished through America and through the engineering profession of America, because the engineering profession of America is really the manufacturing element of America.

I made up my mind that something had to be done several months ago, and instead of sending my boy around I went myself to find out what was necessary, and I found out we must lend these people not money but manufactured articles and raw materials with which to repair the machinery which they now have and which they need so badly, and we must give them time to pay for it. We must find some way in this country to get credit for ourselves, not for these people abroad but credit for ourselves, so that we can lend our manufactures to these people. This procedure is going to require the greatest skill from the standpoint of an executive in engineering, and he must be guided by commercial difficulties, by commercial necessities and by the commercial requirements of these people.

Forget about the money. The money in states such as Roumania is not worth much more than firewood today. The price of fuel oil, as you know, has advanced 13 ct. a gallon. When you use fuel oil in France today it is like using up German marks or Roumanian leu. And therefore the oil in Roumania is as good as the oil in the United States. The wood of Roumania is as good as the wood of the United States. The lumber in Roumania is the finest in the world. As fine salt as is found in Roumania is not found in any other part of the world, nor is it as cheaply mined as it is in the salt mines in Roumania.

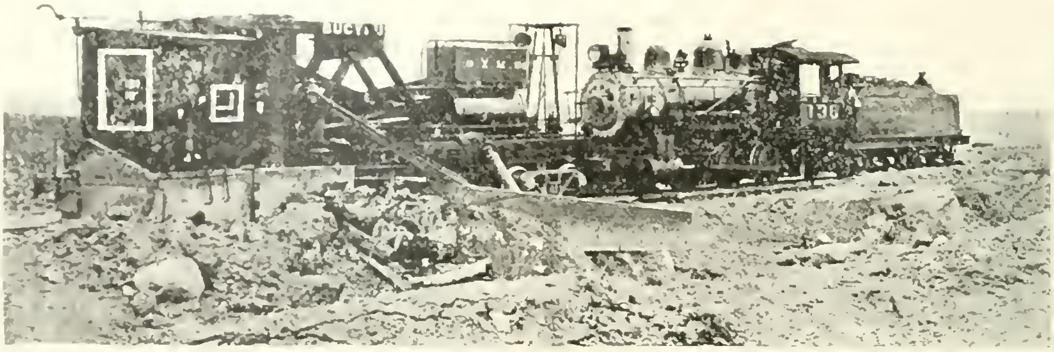
When William Penn came to Philadelphia, instead of offering the Indians money he brought them beads and jewelry and fine linens for their squaws, and was very successful in negotiating for land. And one of these quiet Philadelphians went to Roumania and sold Roumania locomotives for oil. Why not oil? Oil is just as good as money. It is barter. I agree with you, but money is a sort of a barter. But oil is more reliable than money, because oil is always oil and money is not always money.

What Europe Needs.—Now I am not going to tell you just how to do it; but if you want to do it, if you will come up to Philadelphia I will give you a pointer or two; I will tell you. But I am sure if you go over there to sell machine tools and pumping apparatus, electrical machinery, oil machinery—and they need hundreds of thousands of dollars worth of oil machinery because the Germans shot theirs all to pieces—you must do it not for money—they haven't got any—but for barter. Sell it for glass beads, if necessary. Glass beads are worth something in this country, and the freight on glass beads is no more than on anything else. But barter with these countries which have such a depreciated currency. Barter is the way to do business. And therefore we need an executive in engineering who is selling the product of his brain and his factory upon a commercial basis that is suitable to a country that has no money; and if he can educate himself as to how to do it, not only will he be successful and the United States be successful but the people on the other side of the water will be helped tenfold more than they will by any means of supplying them food and clothing without work, that could be conceived in this country.

Tractor-Elevating Grader Outfit Moves 1,500 Cu. Yd. Dirt in Ten Hours.—In building a race track in the Vicksburg, Miss., fair grounds, W. C. Mullen, the contractor, has moved as high as 1,500 cu. yd. of dirt in a 10-hour day with a Western elevating grader hauled by a Holt 10-ton tractor. His daily average, according to the August Earth Mover, has been 1,350 cu. yd. The ground is a soft, boggy, spongy clay, making caterpillar traction desirable. The length of the run is [illegible] ft.; width of the cut, 50 ft.; time to load is given as [illegible] seconds; time to change wagons, 15 seconds; length of haul, 700 ft. Fourteen dump wagons are used to carry away the dirt.

A Method of Building Embankments Without Using Trestles

In the building of isolated embankments, or those that are not made by widening an existing one, either in connection with construction fills and track elevation by railroads, or with spoil dumps by mining companies or individuals, the custom usually has been to construct a trestle to the desired height and extending the full length of the job. Such a trestle must be substantially built in order to sustain the weight of the heavy type of equipment now in use. This procedure, of course, is expensive, as the timber thus used is in almost all cases completely lost, except where caps and stringers can be recovered.



Bucyrus Spreader Plow in Operation on Dumps of Hull Rust Mine. Wing Is at 18 Ft. Width of Spread and 2 Ft. Below Top of Rail.

A method of embankment construction without the use of trestles has been developed at the Hull-Rust dumps of the Oliver Iron Mining Co., of Hibbing, Minn. The work was done with a new type of spreader plow, built by the Bucyrus Co., with the plow a bank 7 ft. high with a top width of 10½ ft., was built alongside a working track.

The methods employed in this work are described in the Railway Review, to which we are indebted for the matter in this article.

The material encountered on the Hull-Rust dumps consists in the main of heavy gravel with a generous sprinkling of boulders. As a matter of demonstration, as well as for practical purposes, a fairly level stretch was selected and the track laid in sections, with the joints broken evenly, in order to facilitate handling. These sections were unloaded from a flat car with a locomotive crane which spotted the sections ahead, the sections being bolted up as fast as laid. This track was put in desirable surface by blocking up temporarily. The first procedure varied somewhat with the character of the material encountered. Where it contained considerable boulders, the load from the first dump was spread level with the top of the rail, thus building a 24-in. embankment. The tracks were then shifted to the top of this newly constructed roadbed. It can readily be seen that with the most careful blocking, the track contained considerable depressions. The facility with which the above mentioned embankment was made level was accomplished by raising and lowering the wing as the material was spread, thus assuring an even grade.

When the material ran even and no large boulders were encountered, the first procedure was to plow 12 in. below the bottom of the tie, attaining this depth in successive cuts. This provided space in which to dump material thus eliminating the tendency of the material to flow back on the rails when dumped from the cars. When this 24 in. embankment was completed, material was dumped to the far side in order to anchor the track. This prevented the shifting of the track, due to the side thrust of the plow during later operations. This material was usually spread off level with the ties. The next procedure was to dump a train of 20 yd. cars from the new track. This was done where the cars stood, without spotting. It proved to be unnecessary to make one continuous pile and to butt the contents of one cars against that of another. This not only facilitated plowing, but saved considerable time.

This dumping of material was spread in three steps with the wing horizontal, on a level with the track, fixed at a minimum spread of 12 ft. from the center of the track. The second step was to plow the same material with the wing fixed at 16 ft. width of spread, and then at the maximum or 22½ ft. width of spread. These operations were repeated three times, making a total of nine operations on this dumping. The same steps were taken each time except that the maximum width was reduced each time 2 ft. or to 20½, 18, and 16 ft. respectively, each time gradually lowering the wing horizontally until the maximum depth had been reached or 2 ft. below the top of the rail. The purpose of decreasing the width each time was to raise the material higher and to lessen the side thrust on the rail and the power required to push the plow, and, furthermore, to attain the object of throwing the material beyond the reach of the wing. The object of feeding down was, as stated before, to provide dumping area.

The base of the material was now 16 ft. from the center of the track. The wing was then raised horizontally to 15 in above the top of the rail and the same dumping was plowed, at the maximum width of 22½ ft. The purpose of this procedure was to carry the ridge over as far as possible and to build a shoulder at this width. It will be seen that this one dumping was plowed ten times.

Then more material was dumped in the space provided, and this was plowed with the wing horizontal. This was repeated until a maximum depth of 24 in. and a 12 ft. width was attained. The wing was then raised to the maximum of 19 in. above the track level and the material was thrown over as described before. At this juncture, a bank had been constructed 5½ ft. in height, above the top of the rail.

The tip of the wing was then raised to the maximum or 7 ft. above the inner end. This consumed about 15 minutes. More material was then dumped and plowed. The plowing was first done with the wing at this inclination at a minimum width of spread. This width of spread was increased in three steps or to 12, 16, and 22½ ft., gradually lowering the wing each time, down to the maximum depth, maintaining the same angle of inclination. This was repeated as often as necessary or until the material lay in a line from the inner point of the wing, 2 ft. below the top of the rail, to the tip of the wing at 22½ ft. from the center of the track. This again provided dumping space for a new load, which was then dumped.

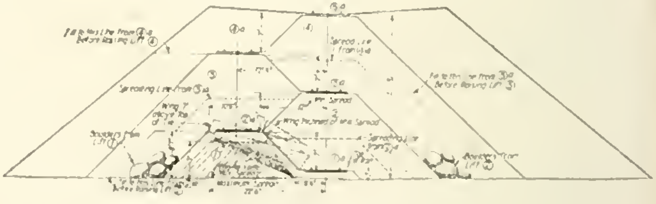


Diagram Showing Method of Building High Bank in 5 Stages with Spreader Plow.

The wing was then raised, maintaining the same inclination, until its inner end was level with the top of the track. The material was plowed, as before, in steps of 12, 16 and 22½ ft., feeding down each time with the wind at the minimum width of spread, as before described, in order to provide dumping space for the next load. More material was now dumped and the same procedure was repeated each time, changing the slope of one bank by bringing in the tip of the wing 1 ft. This added successive wedge-shaped slices to the embankment. This procedure was [illegible] maximum width of spread, 12 ft., was re[illegible] by this time had attained a height of [illegible] with a top width of 10½ ft., this last dimension being [illegible] between maximum and minimum width of spread [illegible] at the maximum inclination.

If it is desired to raise this embankment to a still higher elevation, the tracks may be lifted by [illegible] crane, section by section, and placed on this new embankment, and the above procedure repeated as often as necessary, as shown in the accompanying diagram.

It must be remembered that the procedure here described is that followed on the spoil dump of the Hull-Rust Mine at Hibbing, Minn., but it may readily be seen that conditions encountered elsewhere might alter the method employed in small details. For instance, if boulders were not encountered, the whole procedure would be considerably simplified. It was found that large boulders could be easily plowed and elevated if the wing encountered this boulder below its center. The speed maintained in plowing usually averaged from 7 to 10 miles per hour in ordinary material.

This method of building an embankment requires about double the length of time necessary for spreading a like amount of material in the usual manner, or with the wing horizontal. The saving, however, in timber and fuel, is such a large item that the factor of time becomes negligible. To illustrate, today a 30-ft. trestle for spoil dumps costs from $7 to $12 per running foot, and $12 to $20 per running foot for track elevation work. All of this, as stated before, is lost, except where it is possible to recover the caps and stringers.

The saving in fuel and motive power is accomplished in the following manner: In dumping from a trestle the maximum elevation is established and the grade fixed to that level from the time of the first train-load. Under the new method, this elevation is increased by steps from the ground level to 7 ft., at which elevation the dump is built to cover the area provided and then stepped up again. It may readily be seen how considerable is the saving thus affected on fuel and, incidentally, on the wear and tear of the equipment.

Hydro-Electric Railways in Ontario

A report on hydro-electric railways has recently been submitted to the Hydro-Electric Power Commission of Ontario by Mr. W. S. Murray, Consulting Engineer, of New York. The Toronto-Hamilton-Niagara Falls, The Toronto & Eastern, and The Hamilton-Galt-Guelph-Elmira Rys. are the proposed lines included in this report. Very briefly summarized, Mr. Murray's report states that the construction and operating estimates made by the commission's staff are conservative; that the lines are admirably located with reference to the traffic they are designed to reach; that it is inadvisable to proceed with full construction of these radial lines in view of the inflated costs of labor and material; and that the Commission should proceed with the development of full plans applying to finance and construction in order that it may be in a position to acquire such existing radials as may be economically purchased and which will later form parts of the completed systems.

Some points of interest brought out in the report are as follows:

The construction of the proposed radials will serve to balance the transportation systems centering at the Niagara frontier, inasmuch as at the present time there are seven or eight railroads feeding up to the boundary from the states and only two Canadian roads to take the traffic. These existing Canadian roads will be relieved from a form of transportation which they have stated they are not equipped to handle.

The conservation of coal is referred to and reference is made to the advanced stand taken by Canada in its creation of the Hydro-Electric Power Commission and its promotion of the use of electric power. The fact is stated that in Ontario there is at hand 90 per cent water power, while in the eastern United States the ratio is reversed, 90 per cent of the power being developed by coal.

Colorado Springs Adopts City Manager Plan.—Colorado Springs, at a special election held July [illegible], adopted the city manager form of government, to become effective next April

Blasting Accidents and Their Lessons*

By OLIVER BOWLES and J. E. CRAWSHAW

Mineral Technologist and [illegible]
Bureau of Mines

On April 1[illegible], 1920, a fatal explosion occurred in a limestone quarry in Pennsylvania, causing the death of six men and injury to three others. The conditions were somewhat unusual and are illustrated in Fig. 1. The shot that was being prepared consisted of six 6-in. churn-drill holes in a single row. The line of holes crossed a depression that had at one time been used for the bed of an inclined track. Thus, as shown in Fig. 1, two of the holes were on a bench about 20 ft. higher than the other four holes. The approximate depth of holes Nos. 1 and 2 was 73 ft., and of Nos. 3, 4, 5 and 6, 55 ft. On account of previous blasting operations the rock was in a shattered condition, and hole No. 1 was found to be blocked with rock fragments so that it could not be loaded. It seemed desirable, therefore, to load hole No. 2 with a heavy charge in order to compensate for the absence of a charge in hole No. 1. As the blast under consideration was small a blasting expert was not employed, though it is customary to employ an expert for all large shots.

A line of cordeau detonating fuse was placed in hole No. 2, no electric detonators being used in the hole. After 12 or 13 cases of 40 per cent nitro starch powder had been poured into the hole in loose form, it was found that a space of only 17 ft. remained for stemming. It was decided that space for an additional case of powder might be obtained by tamping the charge. The tamping was done with a heavy plunger, about 3 or 3½ in. in diameter and 10 in. long, made of lead with an iron core with an iron eye in the top to which a ¾ in. rope was attached, and weighing between 30 and 40 lb. This weight was intended for use in sinking explosive in wet holes and not for tamping. It is estimated that the tamping had continued at least 10 minutes. The quarry superintendent had gone a considerable distance for a box of powder, returned and reached a point about 10 ft. from the hole, when the charge exploded, instantly killing the man who was tamping and injuring the superintendent and shovel runner who was also nearby. A group of men were occupied in baling water from the holes in the lower bench, and the rock hurled down killed five of them and injured another.

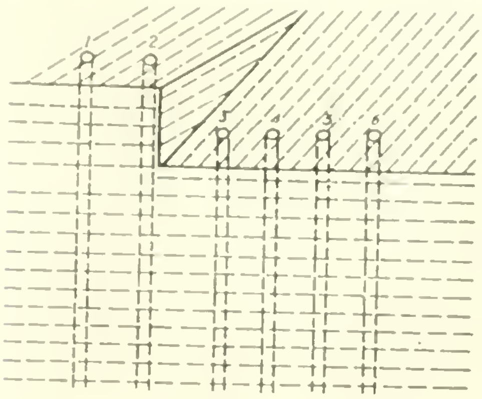


Fig. 1

A number of similar accidents have occurred elsewhere, and the following may be cited:

In November, 1918, while a 70-ft. drill hole was being loaded with 1 by 16-in. cartridges of 50 per cent nitrostarch powder at a cement quarry, a cartridge probably got caught crossways in the drill hole. While attempting to clear the drill-hole by the use of a tripod rammer, the explosive exploded prematurely. The tamping bar on this rammer was a wooden bar 4 in. in diameter and about 10 in. long and at the time of the accident was probably being raised from 5 to 6 ft.

In January, 1907, at Pedro Miguel Locks, Canal Zone, a blast hole was being loaded with 500 lb. of dynamite. For a tamping bar a cocobola stick, 2 ft. 5 in. long, and about 2 in. in diameter, which weighed about 12 lb., was used. This stick was lifted by an attached rope, and dropped on to the explosive. After about 300 lb. had been added and tamped, the explosive exploded prematurely.

---

*[illegible] of Investigations, U. S. Bureau of Mines.

In December, 1912, at Balboa, Canal Zone, while a drill hole was being loaded with dynamite, a rock fell down the hole, closing it up. While an attempt was being made to dislodge the rock with an 18-ft. steel drill, the powder in the hole exploded.

In October, 1912, near Empire, Canal Zone, a workman was tamping 15 sticks of 45 per cent straight nitroglycerin dynamite in a 9½-ft. hole with a steel drill bar 12 in. long, weighing 15 lb., when a premature explosion took place.

In August, 1909, at Miraflores Locks, Canal Zone, while loading dynamite through an iron pipe, the iron pipe became clogged. While attempting to clear the pipe by tamping down hard with a wooden pole, the explosive detonated prematurely.

Many other premature explosions are on record where attempts to force explosives down by the use of unusual pounding have resulted in explosions.

There are certain important conclusions to be drawn from the accident first described, to which careful considerations should be given by every quarryman.

The explosion seems to have been caused by hard tamping with a heavy plunger. With a smooth and regular drill hole such tamping might be conducted without accident, but in an uneven hole having jagged rock projections it seems likely that the heavy plunger impinged with sufficient force on a rock projection to generate the heat necessary to fire a thin film of explosive that may have covered it. Also the shaly condition of the rock in which the hole was drilled probably was a contributing cause. The small particles of rock loosened by the raising and dropping of the weight fell down into the explosive and were ground up by the tamping, making the explosive more sensitive to both friction and impact. Also, possibly some part of the iron constituting the core and eye of the plunger may have come in contact with siliceous rock projections and thus fired the charge. The use of a heavy tamping bar should therefore be carefully avoided.

It is evident that for all purposes a wooden tamping bar should be used. The use of a wooden tamping bar has been urged repeatedly by the Bureau of Mines. Even with a wooden tamping bar the tamping should not be continued beyond the minimum time necessary.

If it is found necessary to use a lead plunger to sink powder in wet holes, it should be provided with a copper rather than an iron eye. The subjecting of any explosive to frequent impacts with any heavy weight is dangerous practice.

A circumstance of extreme importance, is that it resulted in undue loss of life, was the employment of men on a lower ledge adjacent to a face back of which explosive was being placed. The holes of the lower bench should have been loaded first and all workmen removed from the lower bench before loading hole No. 2. Under such circumstances the premature explosion would have resulted in one fatality and two injuries rather than six fatalities and three injuries. While it is unusual to have a single line of holes occupying two benches, the general principle should be followed that workmen should never be allowed at the base of a quarry face after loading has begun, and the presence of workmen on the rock area between the line of holes and the face should be avoided as far as possible.

Every quarryman will observe that the conditions surrounding this shot were quite unusual, and it seems desirable to point out that accidents are much more likely to happen under unusual circumstances than under familiar conditions. Extraordinary conditions result in unusual activities, and the latter involve greater risk. Quarry operators should, therefore, give more careful supervision to blasts of unusual character than to regular blasts where all operations are standardized.

The Bureau of Mines has pointed out that the employment of thoroughly competent blasting experts is to be recommended. Such experts are employed for large shots in the quarry under consideration, but it seems advisable to extend this practice to include all primary blasts.

Quarrymen should familiarize themselves with the various safety rules promulgated by the Bureau of Mines and should endeavor on every occasion to put them into practice. Such rules are contained in various publications, which may be obtained upon application to the Director of the Bureau of Mines, Washington, D. C.

Effect of Railway Conditions on Civil Engineering Curricula*

By CLEMENT C. WILLIAMS,

Professor of Civil Engineering, University of Kansas.

In a recent number of a technical periodical appeared the rather startling statement by the head of the civil engineering department at one of our great universities that no work in railway engineering was required at that institution in the civil engineering course but that all railway work offered there was elective. The statement was all the more noteworthy because this eminent professor is a civil engineer of established reputation, who has entered the educational ranks within comparatively recent years, and therefore, is perhaps least biased in his thinking by educational tradition, and also, because he is pre-eminently a railroad and construction engineer. The reason given for such attitude was the lack of favorable consideration of technical graduates by the railroads in their engineering departments.

This brief discussion is not intended primarily as a comment on the action at the above mentioned institution, but the statement merely accounts to a certain extent for a taking stock of the present situation with a view to arriving at a definite policy that may be rational and justifiable in the light of existing conditions.

In years past, it will be readily enough admitted perhaps, technical schools devoted more time than was justified to the sort of railway engineering that was then taught. This situation resulted largely from a dearth of better material to constitute a civil engineering curriculum, resulting in the offering of courses in railway drawing of a rather useless sort, in stereotomy, in track maintenance including a study of details that were unintelligible to the average student, and extended practice exercises in railway location surveys. These subjects have either been eliminated altogether or have been greatly condensed and concentrated, due to the development of more suitable and essential material for study in civil engineering and due to the prevailing increased effectiveness in teaching.

Reasons for Retaining Railway Engineering in Civil Engineering Curricula.—However, a certain amount of railway engineering is retained in all the civil engineering curricula of the larger institutions with perhaps the exception of the university mentioned above. The retention of such courses probably results from two main reasons.

In the first place, the consensus of opinion among educators seems to be that a curriclum should not be fashioned to meet the needs of a particular type of commercial position or a circumscribed group on such positions, and that if the subjects offered have no broader application than to fulfill the requirements of a certain class of positions, they have no legitimate place in a curriculum. Regardless of the outcome of the controversy between professional pedagogists and psychologists as to whether there may be a transfer of formal discipline from one realm of mental activity to another, it has been amply demonstrated that a given mode of attack in the analysis and solution of one class of problems will aid in undertaking another group more or less similar which may be susceptible to a similar mode of treatment. The methods of railway surveys and earthwork calculations are a case in point, inasmuch as they are applicable to any construction line survey, such as railway, highway, irrigation, drainage or other canal, levee work, etc., differing chiefly in that they are the most precise of the group, and that they have been reduced to more definite and scientific procedure. The diversity of their applicability therefore would justify the retention of a certain amount of railway surveys in civil engineering curricula which aim at training for the general practice of the profession.

Studies in the economics of railway location and construction are likewise justified because the same mode of attack is applicable to highway and any other form of transportation engineering, or, for that matter, to determining the economic significance for any extensive project, and also, because the records and systematic accounting required by the Interstate Commerce Commission render railway operation and performance most readily available for scientific study and analysis. In other words, this type of training and discipline, which is fundamental and of general applicability, can be obtained more advantageously and reliably from studies in railway engineering than in other subjects.

---

*From Bulletin Society for Promotion of Engineering Education.

In the second place, even a casual study of history indicates that transportation and communication have been among the most potent factors in the evolution of industry and civilization and the indications are that they will remain so, and hence, for the liberalizing to a certain extent the curriculum, a modicum of railway engineering is desirable. Obviously, in this connection, the railway engineering that is offered should be more than a study of curves and surveys. It should include an inquiry into the factors that limit the capacity of a railway, or, otherwise stated, the harmonious and consistent design of a railway as a manufacturing and commercial enterprise.

Granted then that railway engineering properly forms a part of a general civil engineering curriculum, it may seem desirable to shift the emphasis somewhat from the purely physical considerations to include a certain amount of the economic phases of railway construction, particularly in view of the changed conditions in the railway situation in this country. While there remain many physical problems of the first magnitude in the future of railway engineering, it is the writer's opinion that perhaps the most complex and important problems of the future are largely economic, although entirely within the realm of engineering. The questions are not those of pure economics, but rather of applied economics—economics that arrives at a definite numerical answer or conclusion.

Economics as Applied to Railway Engineering. It is probably true that railway engineering as generally taught and practiced in the past was too much detached from the vitals of railway operation. A railroad is primarily a plant to manufacture and sell transportation, and railway engineering has been rather remotely connected to either of these processes. Only in the introduction of certain line and grade improvements by means of which heavier tonnage could be hauled has the engineer directly contributed to increasing the plant's capacity to manufacture transportation, and he has seldom had anything to do with increasing the sale of transportation. He has been a rear flagman, as it were, performing a necessary service, but somewhat detached from the main party. As a result, he has been prone to forget his relation to the main plant, and has done little more than—continuing the simile—give backsights when so directed.

The passage of a freight train to many a transitman on maintenance has meant only a brief interruption of his work, a wave of the hand to the engineman, and an indication perhaps of approximately the time of day. Should it stimulate his inquisitiveness and cause him to discover the answers to a number of questions, such as the following for instance, it might bring him to a realization of his relationship to the entire plant. "Is the train that interrupted the work as long as it should be for the grades over this division? Could the division points be changed so as to cause a smaller loss of transportation capacity while passing over intermediate rise and fall? Could traffic be hauled more economically if the grades were reduced? Are all the cars full? Could they be operated full with this character of traffic? Why were there empties in the train? Are empties hauled in the opposite direction also? Where did the cargoes originate? What is their destination? Is this the most economical route? Will the cars return empty or will there be a return traffic available? What could be done to tend to balance the traffic over the line? Does this freight train stand longer on sidings than necessary waiting for passenger or other trains? Should the spacing of sidings be readjusted to prevent such loss of time? Is enough time lost to justify an additional track, entirely or at low speed points? What proportion of the time is this rolling stock moving? Could this train be made to follow the preceding one more closely to advantage by shortening the blocks? What would be the effect on transportation costs if this train were speeded up somewhat? Which does the more damage to the track, this freight or a passenger train? How much more? etc.

Such meditations during odd moments might bring the young engineer to a more definite appreciation of his relation to the entire railway plant organization. Indeed unless the young engineer does enter into vital participation in the operating strategy of the railway, he is likely to find railway engineering a disappointing field of endeavor. Unless he used route to his work that the staking of curves, setting of construction stakes, calculation of estimates and designing minor structures, he will succeed about as well as the structural engineer whose vision is limited to the computation of stresses and the proportioning of parts, or the hydraulic engineer whose capabilities extend only to the determination of head losses and the flow of water. The work offered in railway engineering, therefore, should lead the student to be alert to see the ultimate relationship of the tasks which he may have in hand.

Economic Considerations and Railway Projects.—As suggested above the railway projects of the future will probably be adjusted with a nicety in respect to economic considerations that has not characterized railway engineering in the past. The problems to be solved will be largely those of construction based on a judicious analysis of statistical and economic factors. Radical changes may be expected in the routes of the railways which may give rise to numerous engineering enterprises. The railways are to be regrouped into a certain number of systems in a comprehensively planned scheme on the basis of natural and logical transportation routes, and these routes are likely to be quite different from what they have been previously. Our railways have been largely east and west lines, predicated on the assumption of the Atlantic Coast as offering the only ports of foreign shipping. This conditions may be fundamentally changed in the near future to such an extent as to render the old assumption partially obsolete. Already the Panama Canal has made New Orleans the second export city, and the opening of the Great Lakes to ocean-going vessels via the enlarged Welland Canal making Chicago and other lake cities foreign shipping ports, together with the possible improvement of the lower Mississippi, if found feasible, to admit ocean-going vessels to the middle of the country loading for foreign ports at certain river cities, will profoundly affect the basis on which these groupings are to be adjusted. Our railways will naturally be laid out on a comprehensive unified plan, the basis for which will be controlled largely by the part that America takes in the world's commerce and the arrangement of ports that will afford the most direct shipping, as well as by the conditions affecting domestic traffic.

Changed Railway Situation Will Furnish New Opportunities for Engineers. Because of this regrouping of the railways, extensive improvements will be required in the way of multiple tracking, lines and grade improvement and terminal construction, and the design of these will be based upon an expert analysis of the transportation requirements. While it is out of the question, of course, in the class room to enter into these major problems confronting the railroads, yet many of the general principles determining their solution may be investigated and studied.

Another factor also must be considered in connection with the future railway situation, namely, the improvement of the highways and the development of highway transport, which will inevitably have a potent effect on the character of railway traffic. Unless terminal expenses can be reduced to a marked degree, local freight of small tonnage will be carried by the highways, and under any circumstances, the amount of local freight thus transported will be such as materially to affect certain operating conditions.

Owing to these developments and changes in the railway situation, therefore, the writer is of the opinion that some time that was formerly given to the study of purely physical factors might be appropriately diverted to a consideration of certain more general commercial or economic aspects of the situation. Assuredly the design of location and of terminals, two elements of prime importance in the recasting of the railways that will occur within the next few years, should receive some attention.

Engineers will be indispensable in this program, for it is incredible that an industry of the magnitude of the railways can be efficiently constructed and operated without the aid of technically trained men. Whether these men will all be on the regular staffs of the railways will largely depend upon the attitude of the railways in regard to the payment of its engineers and to the conditions of service.

Unfavorable Conditions in Past Prejudiced Young Engineers Against Railroading.—At the present time, the engineering staffs of the railroads are depleted and young men graduating from college are not attracted to this work—in fact are prejudiced against it because of the unfavorable conditions that have existed in the past. Three major complaints are lodged against the railways by young engineers. (1) low pay, (2) long working hours including Sundays and holidays without extra pay, and (3) small chance for advancement, especially into administrative and executive offices.

If the compensation is made commensurate with the skill and responsibility required, the hours of working placed on a basis similar to that obtaining in other industries, and an opportunity for promotion provided, capable engineers will seek permanent railway service, while on the other hand, if these conditions are not made satisfactory, the more capable men will not enter railway service, for other industries have come to appreciate the value of technically trained men and will offer more attractive opportunities, and in that event, we may expect to find the more intricate and important railway engineering done by consulting engineers of vision and capacity while the railway staff, inevitably under such circumstances composed of mediocre men, occupied in routine maintenance.

This statement is not made in depreciation, for indeed, the condition last mentioned may be in the final adjustment the logical and appropriate one. Cities, water companies, bridge companies, and other industries usually do not retain a large permanent force of high class engineers but for special problems rely on the expert consulting engineer, depending on their regular forces to attend to routine matters of operation. Already there are evidences of the development of the consultant in railway practice comparable to those in other branches of the profession. Whatever, the engineering organization that may do the work, certain it is that railways will need technical engineers, and it seems no more logical to discontinue instruction in this branch than it would be in water supplies because of the fact that water companies and cities do not generally employ regularly expert engineers. It is as reasonable to prepare men for railway work under consulting engineers as for bridge, municipal or hydraulic work under consulting engineers. Such work would be the legitimate practice of the profession.

In conclusion, it is the writer's opinion that a proper amount of railway engineering should be included in a civil engineering curriculum because of the general applicability of the training derived therefrom, although it may be desirable to shift the emphasis somewhat from the purely physical matters to include certain of the economic phases; and that whether the larger work in railway engineering is done by regular staffs or by consulting engineers makes little difference, the fact remaining that an industry of such magnitude as the railways will always either employ or retain technical engineers of superior skill and capacity.

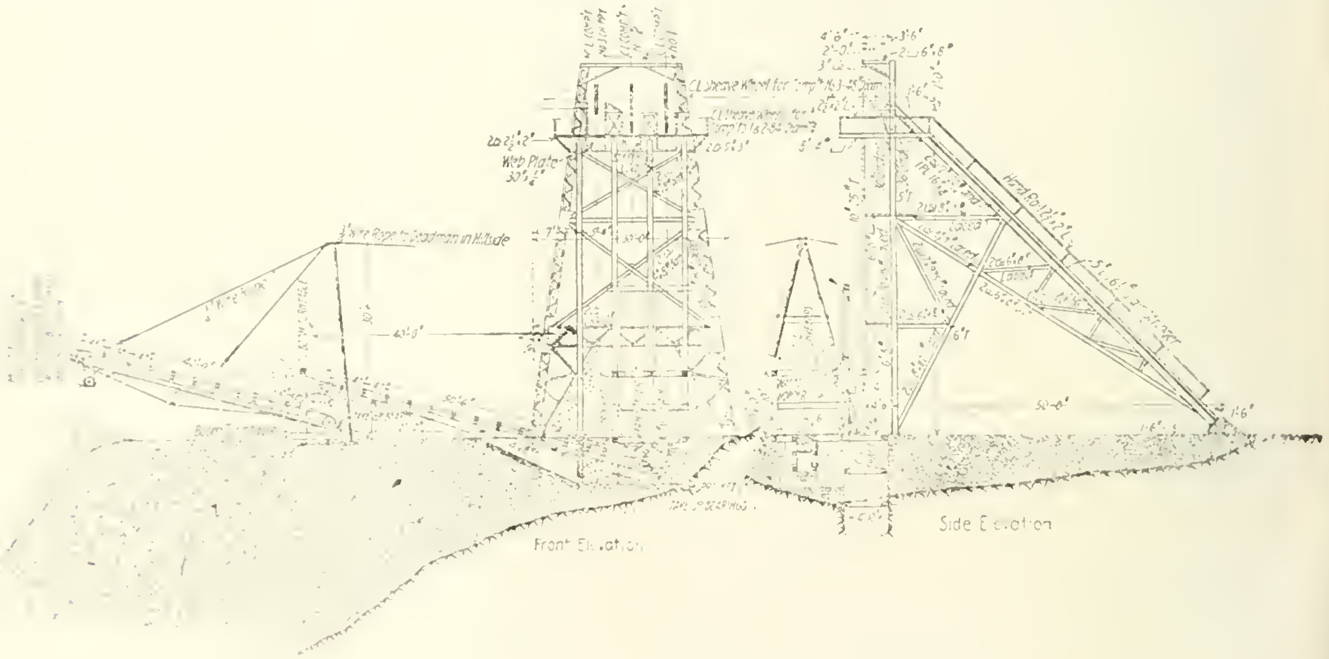
Equipment and Cost of a 1,200 Ton Capacity Mine Hoist*

By J. A. NORDEN and A. R. WILLSON.

The hoisting equipment of the Utah Apex Mining Co. is capable of handling about 1,200 tons per day. It has not been worked to capacity, but 600 to 700 tons, together with men and materials, have been handled in two shifts without any great effort.

A Nordberg engine of the double-drum, geared type, designed for a 10-ton load, including rope, at a speed of 1,500 ft. per minute, is used. The drums are 7 ft. in diameter, with a 54-in. face, and have a capacity of 3,000 ft. of $1\frac{1}{8}$-in. rope. The hoist is operated by a 500-hp. 16-pole, round-rotor, 450-r.pm. motor, which drives through a single reduction of 129 to 19. Speed is regulated by the variable resistance of a rheostat of the liquid, weir-control type. A sodium-carbonate solution is used as a conductor.

The current supply is three-phase, 60-cycle, 44,000 volts, which is stepped down to 2,300 volts by a set of three 250 kv.-a, outdoor-type transformers. From the transformers, the 2,300-volt lines are carried to a bus and switchboard in the hoist room. The average load for starting a loaded skip is about 300 amp. for a few seconds; afterwards, the full-speed running current is 75 to 125 amp. The hoist is controlled by three levers on the operating platform.



Steel Head Frame, Skip Dump, Hopper and Conveyors for Waste Disposal.

At the present time mining operations are in progress on the 100, 1,150, 1,300, 1,500, and 1,800 ft. levels. Three classes of material are produced on most of the levels: First-class or direct-smelting one, second-class or milling ore, and waste. Hence, it was necessary to provide for handling at least two kinds of materials simultaneously at the shaft. The 100-ft. level, being an adit tunnel, has its own waste dump but more or less waste is hoisted to the surface from all of the other levels.

Storage Pockets.—The ore pocket on the lower levels is divided into two parts by a reinforced concrete wall. The ground is hard, requiring no timber, and a small pillar was left between the main storage pocket and the shaft. Below the storage pockets are measuring pockets, which hold one skip load. The top of the storage pocket is covered by an 8-in. grizzly made of 30-lb. rail. On the 100-ft. level due to soft ground, it was necessary to build the entire pocket in direct connection with the shaft.

All ore is dumped at what is known as the 900-ft. level dumps. From here it goes through chutes to the large receiving pockets of the 100-ft. level. Reinforced concrete was used, as the ground would not stand without support.

---

*From Mining and Metallurgy; abstract of a paper to be presented at Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers, Aug. 23-28, 1920.

Surface Dump and Waste Conveyor.—A belt conveyor transports the waste from the hopper of the skip dump to the edge of the waste pile. Due to the steep slope of the hilside at the shaft collar, the waste dump is inclined to creep, especially during the spring thaws. Therefore, a contINOUS stationary conveyor would be impractical and two conveyors were used. The first, which takes its feed from a pan feeder under the skip-dump hopper, is of the stationary type and was extended as far from the shaft as was deemed safe, about 40 ft. The main members of the frame work for this conveyor are anchored to the concrete walls of the pit, making it practically self-supporting. The second conveyor is of the swinging-boom type, and has steel frame work, which is suspended from a bipod. The lower end is hinged on especially designed bearings on a turntable under the head pulley of the first conveyor. This construction not only makes the conveyors independent of the sliding dump, but, as the boom may swing in an arc of about 90°, the total capacity of the piling system is greatly increased. The conveyors are operated with 5-h.p., 440-volt 3-phase, 60-cycle induction motors, rated at 1,700 r.p.m.

The Head Frame, Skip and Cage. The head frame contains no particularly new features. It is a sturdy well-built affair, but is not quite high enough for present purposes. An additional 10 or 15-ft. clearance over the skip when it is in dumping position would be desirable.

The skip and cage are combined. On account of the low head frame, it is necessary to put the cage floor directly over the skip box, leaving only enough room for the latter to work freely. This arrangement would interfere with loading; therefore the floor was made in four sections, hinged so that it can be folded back when rock is being hoisted. The floor is of ⅜-in. plate and is supported by 4 by 4-in. angles, which are bolted to the bale and braces. When men are being hoisted or lowered, doors are used.

The capacity of the skip box is about 70 cu. ft., or 4½ tons of ore. The total weight of the skip and cage is about 5,000 lb.

Costs of Installation.—The following is a statement of the costs of the shaft and equipment:

Year.		Feet.	Total.	Per foot.
1909.	Raising shaft from 1,000-ft. to 700-ft. level	321.5	$ 9,800	$30.48
1913.	Sinking shaft from 1,000-ft. to 1,150-ft. level	152.3	10,300	67.62
1915.	Sinking shaft from 1,150-ft. to 1,300-ft. level	148.6	11,300	76.01
1916.	Sinking shaft from 1,300-ft. to 1,500-ft. level	200.7	19,000	94.66
1916.	Raising shaft from 700-ft. level to surface	726.0	23,000	31.68
1917.	Sinking shaft from 1,500-ft. to 1,800-ft. level and to sump.	400.0	32,700	81.72
		1,949.1	$106,100	

Average cost per foot, $54.44.

Year.			
1916.	Hoist and equipment, house, foundation motor and electrical equipment, etc.	$45,000	
	Head frame, foundation, etc.	15,000	
			$60,000
1919.	Conveyors, skip dumps, hopper, etc., at the surface	$ 5,000	
	100-ft. level pocket and equipment	3,900	
	1,000-ft. level pockets and 900-ft. level skip dumps and equipment	18,000	
	1,300-ft. level pocket and equipment	6,200	
	1,500-ft. level pocket and equipment	6,900	
	1,800-ft. level pocket and equipment	7,600	
	Skips	3,700	
	Total cost, $216,100.		50,000

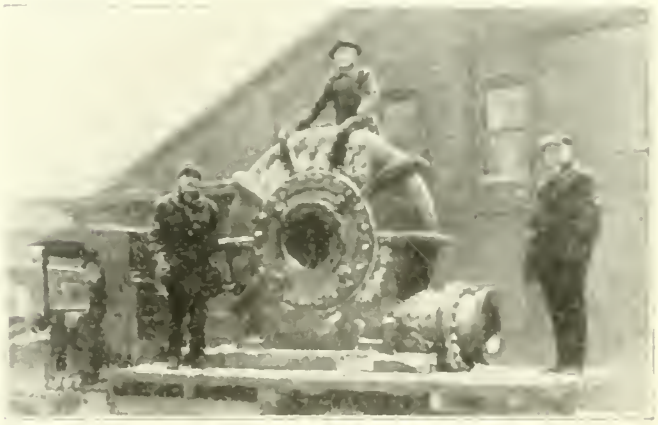
State Organization of A. A. E.—The California Chapters of the American Association of Engineers have just completed the formation of a state organization, the name of which is the California Assembly of the American Association of Engineers. It consists of one delegate from each chapter in the state. The officers elected are T. E. Stanton, of Sacramento, president; Burdette E. Moody, of Los Angeles, vice-president; Ralph E. Dodge, San Francisco, secretary-treasurer. The other delegates are: I. H. Tielman, Fresno; Arthur H. Adams, Long Beach; George S. Hinckley, Redlands; Thomas H. King, San Diego. The State Assembly of the American Association of Engineers will handle all A. A. E. matters of state-wide importance or those concerning matters of interest to several chapters. It will also coordinate the work of the different state chapters and will cooperate with other technical and civic organizations in advancing matters of mutual interest. California, Oregon and Washington now have A. A. E. state organization. California is the third state of the Union in point of A. A. E. membership.

White Iron Pump Shells for Hydraulic Fill Work of Miami Conservancy District

The accompanying illustration reproduced from the June Miami Conservancy Bulletin shows an important advance in the hydraulic fill pumping equipment at the dams of the Miami Conservancy District.

In pumping material which contains as much sand and gravel as that placed in the dam embankments, the wear due to attrition of the interior of the pump shells is uncommonly high. A steady stream of sharp particles of quartz and other hard minerals is thrown by the revolving pump runner at high velocities against the interior surface of the shell, causing rapid erosion of the metal. Especially is this true where the metal is ordinary cast iron. For this reason harder compositions have been proposed, and in some cases used, either for the entire shell, or as an interior lining to take the wear.

The first pumps used on the Conservancy work were of cast iron, and showed rapid wear, the pump shell going on the scrap heap after pumping some 160,000 cu. yd. of earth. Manganese steel gave improved service, the life of this material in the Englewood dredge pump shells being from 134,000 to 182,000 cu. yd. of gritty material pumped. The metal being rather expensive—26 to 27 ct. per pound—Fowler S. Smith, the District's Purchasing Agent, suggested the use of white iron, which is very much cheaper, is at the same time exceedingly hard, and on account of less contraction, can be cast in thicker sections than manganese steel. It seemed to him also that the ability to get replacements of parts in Dayton, where certain firms specialize in white iron castings, would again effect a large saving in shipping charges and expenses due to shipping delays. Mr. A. S. Robinson, the District's Mechanical Engineer, and Mr. William McIntosh, its Master Mechanic, had been planning at the same time an improved design giving added life by increasing the shell thickness beyond that possible when manganese steel is used.



Heavy White Iron Centrifugal Pump Shell.

One other special feature was made a part of the new pump which, on consideration of all the features mentioned, it was determined to build in the District's own shop. This was the radial reinforcing ribs. These were originally wrought iron clamps, slipped over the shell to hold the two halves together after they had split in two with excessive wear, the split occurring on the mid line of the steel casting, at its extreme outside rim. By casting the clamps on as ribs to the original casting, they would hold the halves together until the interior wear had gone to such a point as to reach and make holes through the shell rim. Thus the entire thickness of the shell could be utilized before the casting would be discarded.

The patterns were made in the Conservancy shop, on Mr. Robinson's design, the casting being placed in the hands of the Advance Foundry Co., of Dayton.

The first of the resulting pump shells is shown in the illustration. The weight of the ribs and flanges may appear excessive in places, but was necessary in order to avoid shrinkage stresses in cooling, which might result in weakness and breakage. The thickness of the shell varies somewhat, being greatest at the rim, where the wear is a maximum, and least on the face. This thickness ranges from 5¼ in. On the faces it is about 1½ in.

The pump is a 15-in. pump, absorbing at maximum head 500 hp. and capable of pumping 7,000 gal. per minute at 150 ft. maximum head. The flange on the near face in the illustration is a separate piece, bolted on. The shell proper is machined in only four places—being faced in a lathe on its two faces (to receive the face flanges), on its top (to receive a priming connection) and at the outlet flange face as seen below at the right. (In the picture a reducer connection is shown bolted to the flange).

The performance of the pump shell to date according to the Bulletin has been highly satisfactory. The pump is installed at the Gemantown dam, where it acts as a "booster" in the regular dredge pipe line to the dam top, now 60 ft. above the old creek bed. In this capacity, where the wear should be about the same as in the lower pump, it has pumped to date 110,000 cu. yd., wearing away in the performance ¼ in. of shell. Taking into account that the skin of the casting is likely to be somewhat harder than its interior, the builders estimate a probable total pumping duty of about 400 000 cu. yd. This should be contrasted with the 160,000 cu. yd of the gray cast iron shell at Taylorsville dam, and with the 134,000 to 182,000 cu yd. of the manganese steel shells at Englewood. The extreme thickness of the manganese steel was originally about 2½ in.

The cost of the machined white iron casting was 18 ct. per pound, as against 26 to 27 ct. for the manganese steel, as stated. This relative cost could be reduced in later castings, although market conditions at present would make the actual cost nearer 19 ct. for the white cast iron. Further improvements in reducing cost of pump shell wear are in contemplation, according to the Miami Conservancy Bulletin, from which the above matter is taken.

Time Studies for a Power Shovel*

By DANIEL J. HAUER, C. E.

Construction Economist.

The motion study of serving every machine means much and will bring good results. Time studies of both machines and men can always be made and are valuable, but time studies made of useless motions are only useful in order to discover how to eliminate them. Thus motion studies are first necessary to know that the right motions are being used; then time studies are needed to speed up both the motions and the service to the machine.

It is by such studies that both time and money are saved and the number of men employed kept at the minimum. It is a crime against capital and labor for two men to do the work that one man can do, as well as for a man to do the work that a machine can do cheaper and better.

One great benefit that machines obtain for a job is that they set the pace for the men. Some years ago the writer was selling a machine for construction work and he used a slogan about the machine, which assisted in selling, namely, "It sets the pace for the job."

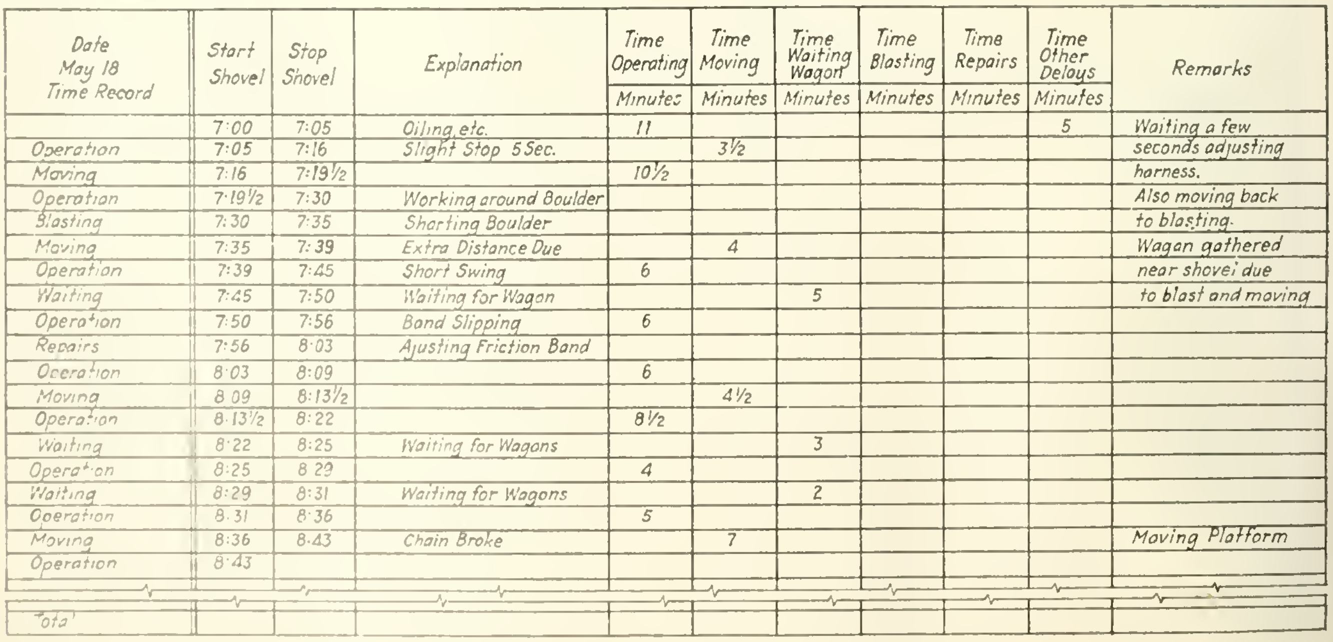
In keeping up to this pace it must be known, as must also the details of the service, to obtain the rated capacity. Thus a steam shovel that can excavate 100 cu. yd. an hour and does only 25 can hardly be called efficient, yet it may not be the fault of either the shovel or its operator, but of the contractor, who furnished insufficient teams or trains. Then in other cases it may be that the shovel is served properly, but the operator is not getting the proper speed from the shovel.

Time studies may be made showing just where the trouble is. The cost of such studies need not be more than a few dollars per day, and the studies may be completed in a week or less, giving a basis for working the job throughout if the proper cost and time system is installed. The ordinary speed for the dipper of a shovel, according to its size and type, is from two to four dipper loads per minute. This is the rated speed and the service and operation should be so conducted as to obtain nearly this speed during most of the day.

The essentials for making studies of a shovel are a hand-counting machine, a stop watch and some properly ruled forms. Such forms are shown in Figs. 1 and 2. These forms can be fastened to a handboard by means of thumb tacks and some blank pieces of paper for use in keeping tab on various features can be fastened in a bunch by a string and attached to the board. In the form illustrated in Fig. 1, a record is kept that shows the speed of the shovel when actually operating, while that in Fig. 2 is a record covering the operation and service to the shovel. In these two records every detail of the shovel's work is set down and it is possible after the day's work is finished to analyze the record so as to see if the operation of the shovel can be improved and also the service.

Thus the first record covers the entire time of actual operation, showing the number of dipper loads the shovel made, the average per minute, the number of wagon loads, the average time for loading and the average number of dippers to the load. These figures will show if the rated capacity both for speed and dipper loads is approached, and if not, some reason for it may be obtained either from this record or that shown in Fig. 2. Here the entire time of the shovel operation for a day is listed, showing the time consumed in actual operation, in moving the shovel, in making necessary repairs, in waits for blasting and other delays.

It is not possible in the limited space available to give a day's record upon the forms, but enough is given to show how Form No. 1 can be used to show the time of the shovel operation and also the detail study of moving the shovel



Date May 18 Time Record	Start Shovel	Stop Shovel	Explanation	Time Operating	Time Moving	Time Waiting Wagon	Time Blasting	Time Repairs	Time Other Delays	Remarks
				Minutes	Minutes	Minutes	Minutes	Minutes	Minutes	
	7:00	7:05	Oiling, etc.	11					5	Waiting a few
Operation	7:05	7:16	Slight Stop 5 Sec.		3½					seconds adjusting
Moving	7:16	7:19½		10½						harness.
Operation	7:19½	7:30	Working around Boulder							Also moving back
Blasting	7:30	7:35	Shorting Boulder							to blasting.
Moving	7:35	7:39	Extra Distance Due		4					Wagan gathered
Operation	7:39	7:45	Short Swing	6						near shovel due
Waiting	7:45	7:50	Waiting for Wagon			5				to blast and moving
Operation	7:50	7:56	Band Slipping	6						
Repairs	7:56	8:03	Ajusting Friction Band							
Operation	8:03	8:09		6						
Moving	8:09	8:13½			4½					
Operation	8:13½	8:22		8½						
Waiting	8:22	8:25	Waiting for Wagons			3				
Operation	8:25	8:29		4						
Waiting	8:29	8:31	Waiting for Wagons			2				
Operation	8:31	8:36		5						
Moving	8:36	8:43	Chain Broke		7					Moving Platform
Operation	8:43									
Total										

Fig. 1—Form Used for Time Study.

---

*From Successful Methods.

and the results of such records, while on Form No. 2 is shown the record for 1 hour and 43 minutes' work.

Comment upon these records will show a great number of things could be done to increase the amount of work without increasing the cost, thus reducing the unit cost of excavation.

First of all, it will be noticed that the shovel did not start on time, five minutes being lost due to oiling the machinery. It is always a difficult matter to start a job on time, especially where machinery is used. If the machine is ready the wagons may be late, or if these are on time there may be a delay due to blasting or for other reasons. In this case the shovel runner lost time in doing work that he could have done before 7 o'clock. The cost for teams and labor on or around this shovel was more than 75 ct. per minute, so that 5 minutes' delay meant a loss of more than $3.75. To pay an engineer for half an hour extra time morning and evening would have been cheap as compared to this delay.

Date May 18 Operations	No. Dips Made	Time Consumed Min	Time Consumed Sec	Average No. of Dips Per Min	No. Vehicles Loaded	Average No. Vehicles Loaded Per Min	Average Time Per Load Sec	Average No. Trips Per Vehicle	Remarks
Shovel	7	2	10	3.4	3	1.4	43	3.33	Wasted a few seconds
Type 0	20	8	45	2.3	10	1.1	53	2	to adjust harness
Gasoline	12	5	30	2.2	5	0.9	66	2.4	Working around
Dipper Size	12	5		2.4	5	1.	60	2.4	boulder
½ Cu Yd	21	6	15	3.4	11	1.8	34	1.8	
	14	5	55	2.5	7	1.2	51	2.	
Wagons Used	22	6	10	3.5	11	1.8	34	2.	
1½ Cu Yds	27	8	35	3.1	17	2.0	30	1.6	
Capacity	14	4		3.5	8	2.0	30	1.8	
No. 8	9	4	56	1.8	5	1.0	59	1.8	Cleaning up pit
Rated Speed									
of Dipper									Moving
4 Dips per			34						Sweeping in the dipper
min revolving		1	10						Moving Platform
90°		1	15						Moving Shovel Up
			30						Blocking Wheels
Bank 6 feet			55						Moving Sweeping in the dipper
deep Some		3	10						Moving Platform, Chain
large boulders		2	15						Broke, Moving Shovel
			45						Platform Parted
									Blocking Wheels
Totals									

Fig. 2—Form Used for Recording Work Done.

It will be noticed that when the shovel started it worked 11 minutes. First 2 minutes and 10 seconds; then with a slight delay due to the fourth wagon adjusting some harness (this should have been done at the stable before the team started, the blame being upon the driver and stable boss) 8¾ minutes, but that the cut at this point was nominal, as it took 3.33 dipper loads to fill a wagon in the first case and 2 dipper loads the second, that the time to load a wagon was nearly a minute, while in other cases two wagons were loaded in a minute.

When the shovel stopped the night before, it made a move, then excavated more than half the available dirt, and stopped. If the operator had worked his shovel for 5 minutes or more after the teams left and moved the remaining dirt ahead of the shovel and then moved his shovel up, this time would not have been wasted as it was, and wagons could have been loaded from the start at the rate of about two a mintue.

It would also have been possible the evening before to have blasted the boulder, which could be seen on the surface and which was partly drilled the night before. Of course to dig around the boulder and expose it meant to save a few pounds of explosive but the extra cost of powder was nothing as compared to the waiting of about $5 while the blast was made. During the first 7 minutes 27 wagons were loaded but if the work mentioned had been done the evening before certainly more than 40 wagons would have been loaded in the same time.

Notice that when the shovel moved ahead and had plenty of dirt, even if some of it was mixed with pieces of broken stone, how rapidly the shovel was operated making more than three dips per minute and loading two wagons per minute. Then, too, note how when the friction band slipped the work was cut down from 1.8 wagons per minute to 1.2 wagons and as soon as this band was adjusted the higher rate of loads was obtained at once. This shows conclusively that as soon as anything is wrong it should be fixed, for machinery out of order gives poor results.

The rest of the record shown in Form No. 2 illustrates that the service to this shovel was poor, as in an hour's time 10 minutes were lost in waiting for wagons. If time had not been lost for other reasons from 7 to 7:15 there would have been lost time due to waiting for wagons. This shovel for the work it was doing should have been served with four more wagons.

Attention should be called to the two records given of moving the shovel. The first one was done rapidly, namely, in 3½ minutes, while the second one consumed 7 minutes. This was due to the chain breaking in moving the first section of the platform. This meant that time was consumed in changing the chains from one section of the platform to another, which could have been prevented by having an extra chain with the shovel. With two chains the shovel was moved rapidly, with one chain much slower. The platform parting was another mishap due to the lack of an extra chain.

The records here shown give the results of loading 81 wagons in an hour and 43 minutes, or an average of 47 in an hour. With a load of 9/10 cu. yd. this means about 425 cu. yd. excavated in a 10-hour day. This can be called a good day's work for a shovel of this kind, yet the record shows that during the 103 minutes, the shovel actually worked but 57 minutes, 19 minutes being consumed in moving, 10 minutes waiting for wagons, 5 minutes for blasting, 7 minutes for repairs and 5 minutes for oiling. If the contractor had given better service to the shovel 27 minutes could have been saved and possibly 30 minutes. This would have meant that at the same rate of operation at least 40 more wagons would have been loaded, making a rate of excavation of about 600 cu. yd. in a 10-hour day, a handsome profit on a day's work, offset only by the cost of four more wagons.

In keeping these records the recording clerk can keep the number of dipper loads with the hand-counting machine. He uses a stop watch for the time. He keeps the record of the wagons loaded by tallying on a piece of paper. The other four columns are filled out by calculations.

By Column 4 the speed of the shovel is shown and the size of the load in the dipper is obtained from Column 8. The service of the shovel by the wagon is shown in Columns 6 and 7. It is by these four columns that quick comparisons are made and the work of both the shovel and the wagons can be analyzed. The greater the number of records the more easily it can be done.

In keeping the record on Form No. 2 the important items is the time of starting and stopping kept by an ordinary watch and the stop watch, the explanations under "time record," "explanation" and "remarks." The rest can be filled in after the field work is done, and from the time columns an analysis can be made that will allow much lost time to be eliminated. Any intelligent clerk can be taught to make such records. The results, though, should be worked up by an experienced man, although it is evident that many of the faults of the service to a machine can be seen from such records by any contractor or his superintendent.

In the case of this gasoline shovel, it would seem that the operator of the shovel was capable of handling the machinery, but rather indifferent as to the details of the pit work. The shovel foreman over him seemed just as indifferent to the same details, being willing to do as others might have done. It has been shown how time could have been saved by them. The contractor, though, was the man who was at fault, for he was not seeing that the proper service was rendered to the shovel.

The Dip Needle in Stratigraphy*

By H. R. ALDRICH.

This paper presents some of the results obtained during the field season of 1919 while mapping in detail the stratigraphy of the Gogebic Range in Wisconsin. The detailed stratigraphic section for the range was first published in 1919 by W. O. Hotchkiss, State Geologist of Wisconsin. The idea of the continuity of the definite succession thus established was the result of underground work in the productive part of the range in Michigan and Wisconsin. The bulk of the range in Wisconsin is heavily covered by drift; in fact, there is but one satisfactorily exposed section across the entire formation, few partial sections, and only scanty outcrops of any size. Evidently, mapping of the detailed members of the formation could only be established at a few points, and if from these small areas the unexposed portions were to be mapped by projection, the only apparent method for projection was straight-line interpolation modified or supported by data from the scanty outcrops and from test workings.

It was found that by tracing a magnetic line, the position of which in the formation may be determined from test pits and outcrops, the projection of that member through the drift-covered areas can be accomplished. The magnetic line serves as a datum horizon within the formation to which reference may be made in correlating outcrops and ledge matter thrown from test workings. The foot-wall is easily located also, and from the two datum horizons thus available and the known proportional thickness of the several members in the type sections, outcrops and artificially exposed ledges can be correlated by lithological characteristics. As a result, the tracing of magnetic lines became the basis of our work on the stratigraphy and we were able to carry the mapping of detailed members throughout the length of the range.

Limitations in the Use of the Dip Needle.—No claim is made for the dip needle as an instrument for final solution of all problems. As an instrument auxiliary to the methods commonly in use for mapping and determining structures in a drift country, its possible utility is far greater than has been commonly considered even in the iron-ore districts. Attention has been called to the difficulties arising when the magnetic horizon has little or no magnetic relief. The difficulty here lies in the fact that several magnetic crests may occur at close intervals and the identity of any one can be established with certainty only when outcrops are found. This offers great difficulty, especially when cross faults are indicated, because due to oxidation or brecciation or other differential effects incidental to faulting, the identity of the magnetic datum may be lost in the local exchange of magnetic dominance among the several lines. In crossing the fault, it is difficult to make certain of picking up the proper line from the several that occur.

In a formation having a gentle dip, the following of a sharp line is practically impossible since the trace of the bed in the surface, even though it enjoys excellent magnetic relief, is not a sharp line but a belt sometimes of considerable width.

Extreme deformation by faulting and folding offers a handicap almost insuperable unless unlimited time can be spent and outcrops are available. This is especially true when the formation as a whole is uniformly magnetic.

Conclusion.—The dip needle and its complementary instrument, the dial compass, offer a service to the geologist that has not yet been fully appreciated, due to two things. First, some geologists have demanded that the magnetic instruments solve geological problems fully or not at all. Secondly, the fundamentals of the instruments and their use have not been understood. It is firmly believed that the use of the needle demonstrated here can be employed more widely and to good advantage by mining companies in the Lake Superior district, and where the rocks are of different character.

---

*From the July Mining and Metallurgy; abstract of a paper to be presented at Lake Superior Meeting, Aug. [illegible]-28, of the American Institute of Mining and Metallurgical Engineers.

"As the Engineer May Direct"

By ERNEST F. AYRES.

Every state in the Union is wondering why its contractors are submitting bids that make the preliminary estimates look immature and stunted. Every civil engineer is bemoaning his sad fate in not being able to meet his bills with his non-elastic salary. Honestly, it looks like a conspiracy to deprive the engineer of his customary three square meals per diem, for if he cannot live on his salary, he certainly cannot live without it when the state closes down all work on account of fever chart bids.

The civil engineer has been held up to the gaze of a wearied world as the man who can get results for a dollar that any chump could get for two. The world frequently retorts that he spends the dollar he saved, and another one on top of it, on needless plans and other fol-de-rols, but that is another story. Colleges, both regular and correspondence, invite ambitious young men to study engineering and then go out into the world and make their fortunes, yet the assistant professors in these same institutions hang onto their steady jobs at a ditch digger's salary. To say the least, it shows a woeful lack of faith in the glowing promises of the catalogue.

The engineer handles more money than any other professional man, unless the banker is included in the list, but he never handles his own cash. He does not have it to handle. For the first few days of each month he acts as a clearing house between his employer and his creditors, retaining a small, and constantly shrinking percentage of the funds as his personal share. The engineer claims to enjoy the respect of the community and to possess an enviable social status. Perhaps, but the respect fails to manifest itself in the pay roll, and the social status cannot be maintained on a shoestring, badly frayed at the edges.

The engineer claims that his wages are fixed by soulless corporations and heartless legislative bodies. Why? These same corporations employ other professional men and pay them well. Why is the engineer in the class of the underpaid preacher and the $75 a month rural school teacher? The physician and the attorney spend no more money in preparation for their life work than does the engineer, but a good doctor or lawyer can settle down and amass a competence for his old age, while the distinguishing mark of the engineer is the patch in the southern exposure of his Sunday best.

A certain engineer violated all precedent a short time ago by reading a set of specifications from cover to cover, and he thinks he has discovered what ails his bank account. It is no wonder that employers decline to pay a man's size salary to anyone as timid as the engineer professes to be in his own specifications.

Pick up any state or municipal specifications at random and see what you find. One of the first clauses states that the engineer declines to guarantee his own figures, but reserves the right to increase or decrease the quantities to suit himself after the contract is awarded. No one ever heard of an engineer cutting the quantities to zero after the contractor had moved his plant onto the ground, but according to the specifications, he reserves the right to do so. Illegal? Of course it is, but think of the mental attitude of the man who is paying the engineer when he finds that his employe is unwilling to trust his own figures. A lawyer may feel that his chances of winning an important case are mighty slim, but he does not advertise the fact. A doctor may have grave doubts of his ability to pull you through that operation, but he does not tell the patient about it. He waits until afterwards, and then claims that the operation was a great success, but the patient inadvertently died.

Ask the contractor just what percentage he adds to his bid to cover the idiosyncrasies of some unknown engineer. It is a miracle that he bids at all.

Keep on reading and you will find the specifications chock full of such clauses as the following: "The work shall be done in accordance with the plans and specifications, or as the engineer may direct." That last clause has broke more than one contractor. What is it doing in there, anyway?

Doesn't the engineer trust his specifications any more than he does his quantities? Is it any wonder that experienced contractors think it more important to know who is to be the resident engineer on the job than to go out and look over the ground? Not that he expects to pay the engineer or induce him to pass defective work or materials, for few engineers have violated the strict ethics of the profession. But he does want to know whether the engineer will use common sense or whether he will insist that the work be done in the most costly and least efficient manner. It has been done.

All specifications insist that the contractor shall familiarize himself with all local state and federal laws affecting the work, and yet these same specifications are full of illegal clauses. The Penalty Clause is one of the most famous. When written, as per usual, wholly one-sided, it has been thrown out of courts so often that [illegible] get up, but still it reappears in the next specification [illegible] cheerfully as if it had never met with misfortune.

The engineer reserves the right to decide any work absolutely. The contractor must start work and stop work according to orders of the engineer and the specifications give him complete authority over methods and organization of all parts of the job. If the engineer knew enough to handle a job of that magnitude, he would not be working for $150 a month. He would be in business for himself. Why hand him authority beyond his abilities?

Of course, the engineer is the big boss, the chief. It must be so for the specifications say so. But everyone knows that in practice the engineer is the inspector on the job. Yet we are pained and grieved when the contractor bids high.

Most of these clauses are dead letters, and both engineers and contractors know it. They date back to the time when the engineer was obliged to guess at his quantities because he did not have the funds to make an accurate survey. His specifications were loose and ambiguous because he had neither the time nor the money to investigate the details as he wished to do. In those days the contractor was more than likely to be crooked. He had to be to live under those specifications. So the contract was filled with a lot of iron-bound, nose-to-the-grindstone phrases to give the engineer the opportunity to apply the screws when necessary.

Today the contractor is a gentleman in a business game where it has been found that honest work pays in real money as well as in complimentary remarks in an epitaph. The engineer has ample funds to carry on his surveys, and ample time to prepare his specifications. Why hold to the old clauses? They are dead and should be buried, for they give a wrong impression of the engineer to the men who employ him, and the result shows up in his pay check.

In state or government work, it is difficult to change the specifications, for most of these old clauses have been woven into the law. Then the Government wonders why its bids are so much higher than for private work of the same character. The specification calls for a large certified check with the proposal. Necessary, no doubt, but who pays for it? The specification calls for a large bond to be given by the successful bidder. Who pays for it? The specifications call for a retained percentage on every estimate until the final, notwithstanding the bond. Who pays for that? The specifications insist that after letting the inspector handle the job, the contractor shall be responsible if the work is not up to standard at any time before the final estimate is paid. Who pays for that clause, and pays high?

The specifications demand that the contractor live up to the very letter of each clause in the contract. One clause in that same contract provides that the contractor shall receive his money at certain times. Did any one ever hear of a state or Government estimate being paid on time? Don't be afraid to speak up if you did. We want to see it framed. Who pays for that delay?

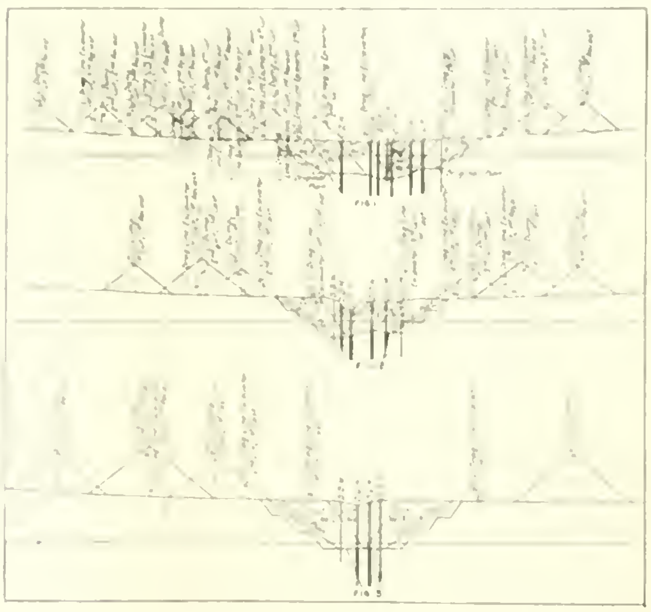
If there are any engineers today who are unwilling to stand back of their own figures, let them say so, retire gracefully and sell insurance on commission. They will not have to pay the policies. The average engineer is a real man, well educated, confident of his ability, and perfectly willing to stand back of his plans and specifications, acknowledge and pay for his mistakes if they occur, and treat his business associate, the contractor, as man to man.

Then, for Heaven's sake, why doesn't he say so in his specifications?

Stripping 85 Ft. Cover from Coal Deposit with Dragline Excavator

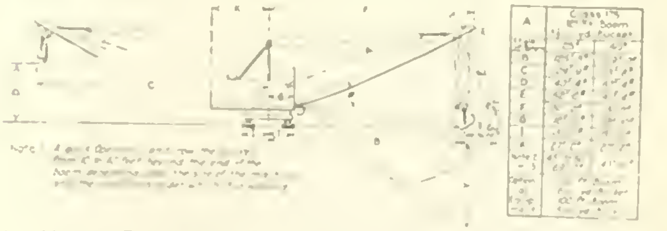
An electrically operated dragline excavator is being used by the Lehigh Coal & Navigation Co. for stripping the 85 ft. of overburden from a coal deposit near Nesquehoning, Pa. The maximum width of the cut at the bottom is 270 ft., while at the top it is 416 ft. The material is mainly gravel and clay with a few boulders but not stratified. Inasmuch as this excavation is believed to be the greatest depth for a single cut upon which a machine of this type has ever been employed, the following particulars from The Coal Age of how the work is being handled should be of interest.

The machine is a No. 175-B Bucyrus dragline excavator. It is operated electrically, two motors being required for this purpose. One of these is of 270 HP. and is used to operate the hoist line, while other is a 150 HP. machine and is used to rotate the excavator. Both of these motors are Westinghouse machines of the slip-ring type. Power for the operation of the excavator is furnished by a high-tension line of the Lehigh Coal & Navigation Co. Energy reaches the plant at 11,000 volts, 60 cycles, 3 phase and is stepped down to 440 volts before going to the machine. The transformers employed are mounted on trucks, permitting their movement from place to place as the stripping proceeds. They are protected upon either side by fuses.



Operations of Dragline Excavator as Planned for Wide, Less Wide and Narrow Cuts.

In Fig. 1 the excavator will make no less than six cuts and will recast the first cut three times, the second cut twice, the third and fifth cuts once, while the fourth and sixth cuts will be handled but once. In Fig. 2 there are but four cuts and only the first and third cuts are recast and this is done only once. In Fig. 3 owing to the narrowness of the cut, only the first cut is recast. The difficulties arise as much from the width as from the depth. The wider the cut the more recasting required.



As All the Dimensions Are Carefully Worked Out It Is Readily Possible to Ascertain the Length of Cast Under Any Given Condition. Every Item of the Excavation Is Plotted Out Beforehand So as to Define the Amount of Casting and Recasting Required.

While the clutches on the excavator are air-controlled, the brakes are hand-operated. The boom is 128 ft. long, while the distance from its attachment to the excavator to the center of the machine is 13 ft. The total reach of the machine, taking into account the angle at which the boom is set, is about 130 ft., while a good operator can swing the bucket 40 ft. more, making an absolute maximum reach of

170 ft. A 1½ cu. yd. bucket is at present employed on the excavator.

The dragline excavators here used has a raised capacity of 140 cu. yd. per hour. This with an 8-hour shift gives a capacity of 22,000 cu. yd. per month. During the summer time this capacity has been increased somewhat, 26,000 cu. yd. having been handled. In winter the ordinary capacity runs to 19,000 cu. yd. per month.

In winter stripping is quite difficult. The machine is situated a considerable distance from any means of transportation and during the past winter from early December it could only be reached by sleds and the men therefore had to be hauled to and from their work three to four miles by sled each day.

Moreover, severely cold weather prevailed, and the frost penetrated the ground in some instances to a depth of 5 ft. This made it necessary to drill and blast the overburden. It is customary to drill three 10-ft. holes about 10 ft. apart and 13 ft. from the edge of the bank. These are sprung or chambered with dynamite, and then each is loaded with three kegs of black powder. The charge is fired electrically. In summer it is of course unnecesary to blast the soil, it being sufficiently loose to be readily dug. Six men handle the dragline excavator. Practically all operations on the machine are performed mechanically, and consequently require only a few men.

The World of the Imagination

By P. B. McDONALD

Assistant Professor of English, College of Engineering, New York University.

One of the main reasons for the need of cultural courses in the curricula of engineering colleges is the introduction which they bring of the great world of the imagination. Students, of course, have been more or less imaginative as boys, but when they undergo the grilling of a technical training, they are likely to become matter-of-fact, narrow and indifferent to what such a practical man as Napoleon Bonaparte called "the great imponderables." An article in a recent British magazine stated that one of the important effects of the spread of education is the widening circle of individuals made acquainted with the world of the imagination. Aside from the value that an active and resourceful imagination brings to an engineer, in making him inventive and original in his work, there is the more significant value which William Morris pointed out in saying that "the mission of art is to allay restlessness." If ever the world was restless, it is restless now; possibly the restlessnes is due partly to stressing of the materialistic in education with neglect of the artistic or cultural. Huxley was wrong in believing that primitive man was entirely materialistic. Such carefully prepared books as "Folkways," "Primitive Culture," and "The Golden Bough," show that man is naturally spiritually-minded, instinctively idealistic, and full of wonder. The imposing of a complicated artificial civilization stifled the wonder in man, but human nature demands compensation and needs the consolation which the world of imagination brings.

Cultural courses properly taught in engineering colleges would unfold to the student not only the artistic attainments of the old civilizations, but also the development of science which began when Cave Men learned to chip flint tools and make a fire. The student would become acquainted with the industrial and human problems that afflicted the long sway of enlightened peoples in Babylon and Egypt, learning how Greece applied systematic reason to the empiricism of the ancient world and pondered over the puzzles of atoms and matter and numbers, and how Rome supplied the practical genius that erred only in becoming too practical. As the student followed the ups and downs of culture and science through ancient and medieval times, he would develop that sympathy with human frailty which study of the exact sciences discourages, and which sometimes gives an arts graduate the advantage.

Perhaps the greatest philosopher of modern times was the Prussian professor Kant. He taught, as Professor Dewey of Columbia University has explained, that we live in two worlds at the same time: the world of science, where we labor at industry and materialistic things; and the inner world of the imagination of the soul, wherein we see all things not as they really are but as our mind interprets them for us. As A. D. Lindsay of Oxford University has stated in his little book on "The Philosophy of Immanuel Kant," "our knowledge is always conditioned by the fact that we are finite minds living in a particular time; but thought can extend the range of perception in space and in time. Mr. Lindsay added, "The great discovery which Kant considered he had made as to the nature of reason was that reason was not a method of observing objects as they really exist, but was concerned directly only with our ways of understanding objects . . . . This new attitude to reason Kant describes as the Copernican change in philosophy." Without going farther into Kant's somewhat complicated metaphysics, in order to show the importance of the imagination in understanding experience, it can be said that most professors of philosophy admit the truth in what Heine called the "destructive and world-smashing thoughts" of this "abstract, old bachelor" who lived his eighty years "in a quiet, retired alley in Konigsberg," where the good wives set their watches by the methodical walks of the little man of the gray frock-coat and cane.

Getting down to more immediate affairs, most of us admit the immense part which imagination plays in our wishes and decisions, determining our careers for us years in advance. What we are not so sure about, speaking of education in its broad sense, is just how to cultivate imagination so that we shall enjoy the gifts of the great minds of the past. Most engineers prefer to take an automobile ride to dig in some dry old book on the Middle Ages or Babylonian inscriptions. What is lacking is a foundation or perspective that would suggest what to read and how to correlate reading with our own experience. Such a cultural course the engineering colleges should give, and give well, making it a point that a teacher of ability have charge of the subject rather than a man who knows exclusively the arts point of view or the engineering point of view. It was such a foundation of education that Sir William Osler had in mind in advocating a combination of the modern sciences and the old humanities. Undoubtedly it was some such idea that actuated a recent writer in "The Irish Statesman." In an article entitled "The Classics and Classical Humbug," this writer, E. R. Dodds, condemns the study of Greek and Latin merely for the sake of painful details about grammar and "unimportant linguistic puzzles," and suggests a revival of classical learning to be studied "in bulk rather than in detail," and to make possible "an illumination of the background of ancient life by the relatively young sciences of archaeology, anthropology, comparative religion, and sociology."

A recent letter in the weekly "Everyman" entitled "Advice on Self-Education" explains that what a working man wants in his serious reading is "to understand the world he lives in, to know, as far as he can, the reason of his existence, of the complexity of the world around him, and of the often incomprehensible strangeness of the ways of God and man." The letter continues, "In other words, he wants not to improve his market value but to grow. It is quite possible that such growth would increase his market value enormously, but that is not his purpose." The new British ambassador, Sir Auckland Geddes, has expressed a somewhat similar idea in saying that the extraordinary change which has come over the world is due to the increasing reluctance of people merely to keep from starving and continue a tread-mill order of things; his solution of discontent lay in the greater emphasis of beauty, service, and truth. Such considerations should have weight in the determining of the cultural courses given to students in engineering colleges.

Slight Decrease in Industrial Activity.—A recent survey by the U. S. Department of Labor of 14 important industries, found that in five there was an increase and in nine a decrease of the number of persons employed in June, compared with May. There was a 5.3 per cent increase in the iron and steel industry and 3.2 per cent in car building and repairing. The decreases were 6.4 per cent in woolens, 5 per cent in hosiery and underwear, and 3.7 per cent in leather manufacturing.

Santa Fe to Build 200-Mile Branch.—The first branch railroad building of any size, undertaken since the return of the railways to private ownership, will, it is reported, be the construction of a 200-mile line from Garden City, Kan., to Trinidad, Colo., by the Santa Fe System. It is said work will be started this year.

Relative Reliability of Steam and Electric Operation

The frequently raised question as to the relative reliability of steam and electric operation is answered in a table reproduced herewith from the Railway Age which was prepared by Mr. R. Beeuwkes, Electrical Engineer, C. M. & St. P. Ry., as part of a paper presented before the convention of the National Electric Light Association at Pasadena, Cal.

Item 11 shows that the electrically operated territory shows less time delayed than any of the steam operated divisions, except that between Avery and Cle Elum, a district particularly favored as regards its freedom from climatic, topographical and other conditions which tend to cause delays. Attention is also called to the favorable showing, for electricity, of items 24 and 25.

RECAPITULATION OF "PASSENGER T[illegible] [illegible]FORMANCE" [illegible]HOWING DELAYS TO PASSENGER TRAINS ON THE BASIS OF MILES OF LINE OPERATED [illegible] MONTHS OCTOBER NOVEMBER AND DECEMBER 1[illegible] [illegible] JANUARY FEBRUARY AND MARCH 1920.

	Delayed time in minutes per [illegible] line operated				
Division	Mobridge to Marmouth	Marmouth to Harlowton	Harlowton to Avery	Avery to Cle Elum	Cle Elum* to Seattle
Motive power	Steam	Steam	Electricity	Steam*	Steam
Miles	190	340	4[illegible]	[illegible]	[illegible]
Item.					
1. Meeting and blocked behind passenger	18.83	11.33	17.15	10.[illegible]	[illegible]
2. Meeting and blocked behind freight	[illegible]	5.88	6.49	1.98	2.84
3. Extra cars	1.23	0.58	0.02	[illegible]	[illegible]
4. Excess time switching	1.25	2.66	2.16	1.54	4.31
5. Electric block signals	0	0.13	3.52	4.07	10.62
6. Slow orders	4.54	1.37	1.29	[illegible]	[illegible]
7. Bad weather and poor coal	[illegible]	13.59	[illegible]	[illegible]	[illegible]
8. Engine condition	[illegible]	25.20	[illegible]	[illegible]	10.54
9. Accidents and derailments due to engine	[illegible]	2.25	0.15	7.85	2.05
10. Trolley and sub-station	[illegible]	0	3.03	[illegible]	0.
11. Total of items 1 to 10 inclusive, which are affected by the type of motive power used	172.65	62.95	52.73	[illegible]	54.93
12. Ave. of items 1 to 10 inclusive, for the four steam divisions [illegible]					
13. Awaiting connections	[illegible]	1.16	0.02	1.82	1.94
14. Handling extra heavy bag mail and express	6.79	3.26	2.09	1.20	0.97
15. Extra stops for passengers and railway crossings	0.52	0.97	1.99	0.22	1.13
16. Car conditions	[illegible]	18.05	9.75	6.87	6.10
17. Accidents and derailments not due to engine	27.69	12.51	17.75	[illegible]	30.49
18. Slides, earth, rock and snow	2.73	0	3.64	[illegible]	[illegible]
19. All other causes	[illegible]	1.78	11.03	1.91	9.95
20. Total of items 13 to 19 inclusive, which are not affected by the type of motive power	[illegible]	37.85	[illegible]	33.86	103.69
21. Ave. of items 13 to 19 inclusive, for the four steam divisions 16[illegible]					
22. Total of all items	230.45	100.80	99.03	69.20	158.62
23. Ave. of items 13 to 19 inclusive, for the four steam divisions 121.52					
24. Minutes lost on schedule running time per mile of line operated	[illegible]	[illegible]	8.91	0.00	162.2
25. Minutes made up per mile of line operated	46.6	35.6	100.00	81.00	11.54

*Electrical operation commenced in March.

In conclusion Mr. Beeuwkes states that in no respect have the results of the electrification failed to equal the expectations of the railway organization, and in most respects these expectations have been far exceeded. The extent of the electrification is such as to leave no doubt as to the practicability of indefinite expansion with an insurance of increased reliability and safety and a marked and determinable increase in capacity. Items of operating expense dependent on whether steam or electricity is used as a motive power we have found by experience and estimates to be so reduced and the benefits indirectly obtained to be so great as to render justifiable, even with the increased investment charges, the serious consideration of indefinite extension of electrification, even for lighter grades.

Rail Joint Reclamation

On the New Orleans Electric Railway very substantial savings have been made by reclaiming rail joints, which are taken out of track that is to be rehabilitated. The Electric Railway Journal states that Mr. M. V. Houlard, Superintendent of Track, is reclaiming about 6,000 joints a year, and at a cost of 80 cents for material and labor, as compared with $2.50 to $3.50 for a new angle bar.

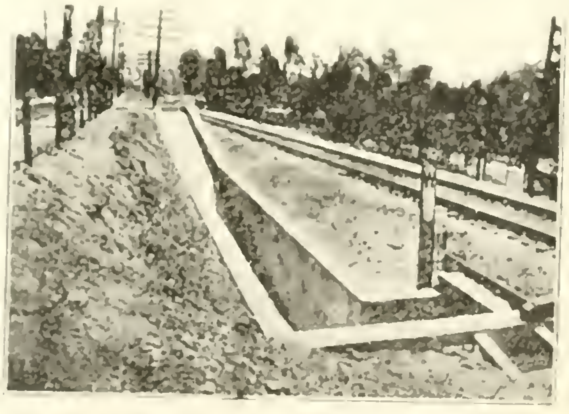
As the old angle bars are taken out of the track they are accumulated at the track storage yard. There they are sorted and stored in neat piles and as rapidly as a small crew of men can handle them they are reclaimed and restored ready for future use. If they are bent they are heated and straightened in a press. They are often worn as much as ¼ in. at the top, and sometimes the bottom is somewhat worn. Slightly more than enough new metal is then deposited along the edges to make up for any amount that has been worn away.

The final step is to grind off the top and bottom edges so that the plate will fit the rail properly. This is done by bolting the plate [illegible] a Goldschmidt [illegible]. It is claimed that a better [illegible] these reclaimed plates [illegible] be made to take into [illegible] as well as the old plate has [illegible] extent, whereas a new angle bar would be [illegible] to a new rail.

A Safety Underpass

At Sycamore Grove, a suburb of Los Angeles, Cal., the street car line and the railroad track are parallel at this point, and most of the street car patrons live at the opposite side of the railroad tracks, making it necessary for them to cross the railroad tracks to reach the street cars. The trains pass here frequently, at a high rate of speed, and there is a curve in the railroad track at this point, so that when large numbers of people are crossing the tracks, the element of danger is a matter of concern.

The usual, and cheaper, arrangement for a subway at such a point, would be to enter it by direct descent on a stairway, but crowds of people cannot move rapidly over stairways; and there is, also, the liability to injury by people stumbling and falling on steps, especially when moving in a hurry or under the pressure of a crowd behind. To relieve the situation of danger of this kind, as well as to make the approach to the subway from the street railway side convenient and easy, the subway has been built with an incline. The level of the floor of the passageway, at the foot of the concrete incline, is 10 ft. below the level of the rails.



Incline, as Seen from Subway.

The illustration above, together with the description, is reproduced from the Railway Review.

Wages Increases of Railway Employes

The following table summarizes the wage increases awarded July 20 to employes of the railroads of the country by the Railway Labor Board:

Class of employes	Number of employes	Average per month April 30, 1920	Increases granted per month.
General officers*	7,132	$359.60	$ . . .
Division officers*	12,511	245.47	. . .
Clerks†	216,764	111.83	26.52
Messengers and attendants	10,122	70.44	26.52
Assistant engineers and draftsmen	10,370	138.96	30.60
M. W. and S. foremen	8,119	142.68	30.60
Section foremen	40,899	108.18	30.60
General foremen, M. E. dept.*	1,707	259.51	. . .
Gang and other foremen, M. E. dept.	23,592	195.41	26.52
Machinists	59,067	142.18	26.52
Boilermakers	18,413	147.74	26.52
Blacksmiths	9,898	136.37	26.52
Masons and bricklayers	1,186	115.37	30.60
Structural ironworkers	673	131.58	30.60
Carpenters	50,854	117.30	30.60
Painters and upholsterers	12,632	118.64	36.52
Electricians	13,200	143.97	26.52
Air brake men	7,781	132.37	26.52
Car inspectors	24,258	145.71	26.52
Car repairers	30,417	123.33	26.52
Other skilled laborers	46,307	132.15	24.48
Mechanics' helpers and apprentices	107,263	95.13	26.52
Section men	286,300	77.80	17.34
Other unskilled laborers	118,932	87.60	17.34
Foremen of construction gangs and work trains	1,910	128.04	30.60
Other men in construction gangs and work trains	30,306	81.84	17.34
Traveling agents and solicitors*	1,355	177.60	. . . . .
Train dispatchers and directors	5,413	328.13	26.52
Telegraphers, telephoners and block operators	20,859	126.46	20.40
Telegraphers and telephoners operating interlockers	8,243	131.43	20.40
Levermen (non-telegraphers)	3,926	125.28	20.40
Telegraphers' clerks	11,362	129.23	20.40
Agent telegraphers	19,065	139.64	20.40
Station agents (non-telegraphers)	13,898	138.50	10.20
Station masters and assistants	605	161.01	. . . . .
Station service employes, not otherwise covered	115,255	93.52	20.40
Yardmasters	3,905	247.30	30.60
Yardmasters' assistants (not yard clerks)	3,122	216.17	30.60
Yard engineers and motormen	19,153	175.14	36.72
Yard firemen and helpers	19,559	126.03	36.72
Yard conductors or foremen	18,785	159.09	6.96**
Yard helpers	47,815	141.51	6.48**
Yard switch tenders	6,129	120.76	5.04**
Hostlers (outside)	10,687	132.83	6.24**
Engine house men	68,585	104.55	5.60**
Road freight engineers and motormen	30,405	223.86	31.20
Road freight firemen and help.	31,608	156.72	31.20
Road freight conductors	24,501	194.73	31.20
Road freight brakemen, flagmen	6,525	145.70	31.20
Road passenger engineers and motormen	12,761	256.41	24.00
Road passenger firemen and helpers	12,413	184.19	24.00
Road passenger conductors	10,649	226.20	30.00
Road passenger baggagemen	5,669	126.33	30.00
Road passenger brakemen and flagmen	15,626	151.43	30.00
Other road train employes	3,415	120.09	30.00
Crossing flagmen and gatemen	23,069	78.68	17.34
Drawbridge operators	1,069	98.75	17.34
Floating equipment employes	9,288	135.66	17.34
Policemen and watchmen	11,541	117.79	20.40
Other transportation employes‡	5,470	97.52	. . . . .
All other employes‡	20,876	82.91	. . . . .
Total	1,888,229		

*Not included in award. †Of more than one year's experience. **Indicates the amount this class of employe will be paid per diem under the new scale. Variation in the pay of this class throughout the country caused the board to fix a flat day wage instead of an increase in rate per hour. ‡Increase fixed by rate granted for analogous service.

News Letter

St. Louis Items

By A. B. KOENIG.

P. E. Shugart, Nevada, Iowa, was awarded 10 miles of second track work and the contract for grading yards for 24 tracks one mile long by the Illinois Central R. R. at Clinton, Ill. Can use some small team outfits on this job.

A. P. Nolan, 4563 Wichita avenue, St. Louis, Mo., has one new 1 yd. Osgood and one ¾-yd. Thew shovel idle. Wants to place them on some work in this neighborhood.

Donaldson & Burcher were awarded contract for building a number of bridges for the Poinsett Lumber & Mfg. Co. R. R. near McDonald, Ark. They are also constructing a concrete levee at Newport, Ark.

T. M. Coleman will finish his State road work near Burwell, Neb., in a few days. Wants some new work for his six team outfit in that neighborhood.

Henry Schweitzer is building a spur for the Valmeyer Quarry Co. near Valmeyer, Ill. Also constructing a reservoir at Marion, Ill.

Allhands & Davis, Hugo, Okla., can use several 10 or 12 team outfits on bank widening and ditching on the Frisco railroad in Oklahoma.

Scott & White, 806 Merchants Laclede building, St. Louis, Mo., have 60,000 yd. of grading on the Frisco railroad near Lebanon, Mo., to sublet.

Cameron, Joyce & Co., Keokuk, Iowa, want to sublet 27,000 yd. of side borrow work on the Northwestern railroad near Nelson, Ill. Free transportation for labor and outfits over the Northwestern railroad.

D. C. Gahan has moved his team outfit on a hard road job at Carlinville, Ill.

M. Hayes & Sons write us from Jewett, Ill., that they are about through at that place and are in the market for any kind of grading suitable for a 20-team grader and wagon outfit.

R. T. Amis, Lebanon, Mo., has about 150,000 yd. of steam shovel work to let. All classified material.

The Frazier-Davis Const. Co., 1170 Arcade building, St. Louis, Mo., have 50,000 yd. of wheeler and fresno work near Vandalia, Ill., to sublet.

Thos. L. Rosser, Jr., Earlham, Ia., is in need of some team outfits.

The L. J. Smith Const. Co., Kansas City, Mo., have started to build 46½ miles of railroad from Uvalde to Cedar Brakes, Tex. The contract covers grading, bridging, track laying, depots, section house, machine shops and telephone lines.

Morton C. Andrews, 58 years old, vice-president and general manager of the Unit Construction Company, died suddenly in Fall River, Mass., on Aug. 9. Mr. Andrews was in the east, accompanied by his wife and five children, superintending the construction of an oil refinery which is being constructed by his company. Details of the death were not included in the telegram. He was personally superintending the construction of the refinery in Fall River, owing to the immense proportions of the building. It is said that the completed refinery will cost $6,000,000. The funeral was held in Danville, Ill., Mr. Andrews' former home.

Pat Hickey of Hickey Bros., Mr. Hanson of the McArthur Bros. Co. and Mr. Daley of the Walsh Const. Co. returned from an inspection tour over the Texas Pacific railroad.

Contractors when in want of work or labor write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo.; 503 Delaware St., Kansas City, Mo., or 1020 Douglas St., Omaha, Neb.

Industrial Notes

The Weller Manufacturing Co., Chicago, are now represented on the West Coast by the Oriental Supply Syndicate, Inc., 688 Howard street, San Francisco, Calif. They are in a position to quote prices on the full line of Weller Elevating, Conveying and Power Transmitting Machinery, also grain and Rice Driers, Portable Bins, Steel Chain Equipment for Canning plants, etc.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa. The George Cutter Works of the Westinghouse Electric & Manufacturing Company, South Bend, Ind., is making extensions which will double its manufacturing capacity. These extensions include a new foundry space of 64 feet by 112 feet, and a second floor measuring 66 feet by 250 feet, for assembling and storage rooms. In addition outdoor storage space has been obtained which will increase the facilities greatly.

Pierce-Arrow Motor Co., Buffalo, N. Y.—Announcement is made of an expanded line of motor trucks powered by Dual Valve engines, including 5-ton, 3½-ton, and 2-ton trucks and a tractor unit, each equipped with double ignition and electric lights. It is stated that the Dual Valve engine for trucks, following the design for passenger car service, has been in process of design and test for more than two years, and that extended usage under actual working conditions has demonstrated economical and efficient service. Basic engineering principles are maintained, but with refinement of design new records have been establishd for maintenance and repair costs. Details regarding specifications of the new models and performance records may be obtained from the company or its distributors.

Trade Publications

Motor Trucks.—Acme Motor Truck Co., Cadillac, Mich. 16-page booklet describing and illustrating various sizes and types of trucks for widely varying uses.

Low Level Multi-Jet Condensers. Ingersoll-Rand Co., New York. Illustrated pamphlet describing range of use and simplicity of construction together with efficiency curves.

Wire Rope.—Broderick & Bascom Rope Co., St. Louis, Mo. "Yellow Strand," an illustrated 12 page monthly pamphlet describing various applications and uses of wire rope.

Wood Preservation.—C-A-Wood Preserver Co., Arcade Bldg., St. Louis, Mo. A series of questions and answers regarding wood preservation with illustrations and definitions of trade names.

Corrugated Metal Culverts.—The Canton Culvert & Silo Co., Canton, Ohio. 48-page booklet illustrating and describing "Acme" (nestable) non-corrosive metal culverts. Contains information regarding construction, shipping, storage and handling, gauges, lasting qualities, capacities, and special adaptation for steam and electric railway use.

Personals

Ralph R. Benedict, formerly assistant superintendent of parks of Kansas City, Mo., and for the past two years with the Ordnance Bureau of the War Department at Washington, D. C., has been appointed assistant to the Chief Highway Engineer, State of Illinois, Department of Public Works and Buildings, Division of Highways.

J. Clark Keith, formerly engineer in charge of design and construction for the municipality of Moose Jaw, Sask., now of Morris Knowles, Ltd., of Windsor, Ont., has been appointed assistant chief engineer of the Essex Border Utilities Commission, having jurisdiction over the water supply, sewerage and park systems of the seven municipalities bordering on the Detroit River.

Mr. Charles E. Henderson, manager of the Windsor, Ont., branch of Morris Knowles, Ltd., has been appointed division engineer in charge of the Detroit office of Morris Knowles, Inc. Mr. Henderson was at one time assistant city engineer of Port Arthur, Ont., later going to St. Augustine, Fla., as city engineer. He was with the United States Housing Corporation during the war as principal assistant engineer at Washington, D. C.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., AUGUST 25, 1920. Number 8.

Is a Technical Article an Advertisement When It Gives Publicity?

Within the past two years the Post Office Department has made several rulings relative to the meaning of the term "advertisement" that are regarded by publishers as being entirely arbitrary and unreasonable. For example, if a book review mentions the price of the book, the article is classed as an advertisement and the publisher is required to pay postal charges that apply only to advertising matter.

That was bad enough, but even worse was the ruling that if any article chanced even to mention the name of a book or machine an advertisement of which appeared in the same issue of the periodical, then that entire article is also classed as an "advertisement." Thus, the editor of Engineering and Contracting made editorial reference to a certain page in his Handbook of Cost Data. In the same issue it happened that the publisher of the book advertised it. Whereupon the P. O. classed the editorial as an "advertisement."

Hoping that the P. O. Dept. head could be induced to give at least a semblance of a reason for such rulings, the editor wrote the following letter to Postmaster General:

> In your interpretation of the meaning of the word "advertisement" in the postal law it seems to me that you are making a serious error.
>
> Any article in a periodical is classed by you as an "advertisement" if it gives the name and address of a manufacturer. That such an article gives "publicity" to a firm or its product, I grant. But when was "publicity" ever synonymous with "advertisement"? All advertising is publicity, but much publicity is not advertising.
>
> The word advertisement implies payment, direct or indirect, for publicity. When a publisher receives no payment from any firm for an article mentioning a firm, or its product, the article is certainly not an advertisement in the ordinary acceptance of the term.
>
> The authors of practical engineering books often give the names and addresses of the manufacturers of machines and products mentioned. Yet no one has yet said that those books are advertising media. True, they give publicity to firms and products, but the firms do not pay for the publicity; hence it never occurs to anyone to call such publicity advertising.
>
> Last week I incidentally mentioned one of my own books in an editorial in Engineering and Contracting, and because it chanced that my publisher happened to have an advertisement in that same issue, my entire editorial was classed by the post office as an advertisement.
>
> As nearly as I can make out, your criterion of whether or not an article in a periodical is an advertisement is this. Any article that tells a reader something definite about a product is an advertisement, if the name of its manufacturer appears either in the article or on one of the advertising pages. If we publishers omit the name and address of the manufacturer, we receive many inquiries from readers asking where the product can be procured. So we are penalized by our readers if we omit an address, and we are penalized by the post office if we insert it.
>
> Webster defines advertisement thus: "A public notice, especially a paid notice, in some public print." He gives only two other definitions, one of which is marked "archaic" and the other "obsolete."
>
> You will greatly oblige not only me but all magazine publishers by giving me your authority for the interpretation of the word "advertisement" in such a way as to warrant calling an unpaid article an advertisement.

Note particularly that the editor requested a citation of authority for the definition of "advertisement" used by the P. O. Dept. In the letter from the P. O. Dept. replying to the one above given, no dictionary or other authority was cited, but the following explanation was given by the Third Assistant Postmaster General:

> In answer to your letter of March 21, 1919, which the Postmaster General has referred to me, concerning the interpretation that has been placed on the term "advertisement" as used in the Act of October 3, 1917, which fixes a higher rate of postage on the advertising portion of a publication than on the non-advertising matter, I have to say that in administering the law governing the entry of publications as second-class matter it has always been the practice to regard as advertising, write-ups, puffs and commendations of articles advertised for sale in a publication. When a publication consisted largely of such matter it came within the provision of the law prohibiting the entry as second-class matter of publications "designed primarily for advertising purposes," and was, consequently, denied such entry. When,

as is the case with respect to your publications, such write-ups of articles advertised in a publication formed only an incidental feature as compared with the publication in its entirety, the matter, although advertising nevertheless, had no effect on the second-class mail privilege of the publication nor, prior to the date the Act of October 3, 1917, became effective, on the rate of postage applicable thereto, the same rate being chargeable on both the advertising and non-advertising portions. Under the Act of October 3, 1917, all advertising must be considered, regardless of whether it is paid for, or inserted free, and charged with postage at the zone rates applicable to the advertising portion.

In accordance with the foregoing, matter appearing in the reading columns of a publication in the form of a write-up, puff or commendation of something advertised in the same issue of the publication, which is obviously connected therewith for a promotive or advertising purpose, is regarded as advertising within the contemplation of the Act of October 3, 1917, and, consequently, subject to the zone rates of postage applicable to advertising matter.

Matter relating to or descriptive of some new device, article or project when so prepared as to be free from promotive or advertising features is not regarded as advertising, provided the matter is not published in connection with an understanding or agreement with anyone interested in the sale of that which is featured, and no advertisement of the builder, manufacturr or other interested person appears in the publication. But when matter is so written as to constitute a puff or commendation tending to advertise or promote the sale of the device, article or other object featured it is chargeable under the law with the advertising rates of postage even though no display advertisement concerning it is carried in the publication. In other words, free advertising which a publisher gives the advertiser or seller of goods is not relieved from the payment of postage at the rate prescribed by law for advertising matter merely because the publisher inserts it without charge.

In short, any published language that tends to promote the sale of any advertised product is an "advertisement," and even an incidental mention of the product suffices to promote its sale. We believe that any jury of intelligent men would not support such a definition. Suppose, for example, the Holy Bible were mentioned in an article in a periodical carrying an advertisement of Bibles, then under this P. O. definition the article would be an advertisement.

It is clear to us that the P. O. Dept. fails to distinguish between "publicity" and "advertising," the former being the broader term, the latter indicating paid publicity.

Why Has the Metric System Not Been Adopted in America?

It has been claimed that James Watt, the great British inventor, was the first man to submit to the different nations a decimal system of weights and measures. That was in 1783. Tallyrand, the French statesman, saw at once the immense practical value of Watt's system, and caused it to be adopted in France under the name of the metric system.

In his first message to Congress, George Washington said:

> A uniformity of weights and measures is among the important objects submitted to you by the constitution and if it can be derived from a standard at once invariable and universal, it must be no less honorable to the public council than conducive to the public convenience.

In 1786 America adopted a decimal system for her money, thus being the first nation to have metric money, but unfortunately did not adopt the meter liter-gram units.

It is not unlikely that the Latin derivation of the names of the metric units and sub-units has had an effect in delaying the adoption of the metric system, but the principal causes of delay have been mental inertia and the fear that the cost of making the change would outweigh the profit securable from the change. Mental inertia probably could be overcome were it clearly demonstrated that a change to the metric system would result in a marked net gain in dollars. Although we have read many articles and pamphlets pro and con, we have yet to see even a crude attempt at a proper solution of this economic problem. Such a solution should contain an estimate of the total cost of making a change to the metric system in America, accompanied by an estimate of the present worth of the future annual gains resulting from the change. We believe that if this problem were assigned to a competent engineer, an approximately correct solution could be secured in a relatively short time and at no great expense. But the prevalent method of solving social problems is not the engineering method just outlined. The prevalent method is the Robinson Crusoe way, or the debating school method, which consists in marshalling as many pro arguments and as many con arguments as can be conceived, and then guessing as to which total is the weightier.

It is our hunch that if each pro and con argument is reduced to dollars, it will be found that adoption of the metric system will be proved to be very profitable to America. Certainly its adoption in Germany in 1871 has been regarded by Germans as having been a highly economic act.

The following is a summary of the nations that now use the metric system:

> There are 34 nations which by official signature have formally contracted to use exclusively the metric system. There are 200 countries which now use metric units, even though they do not use metric names, or the whole system. India is a good example. Countries which have all of them more or less completely adopted the metric units are these 200: Argentina 1863, Austria, Adalia, Algeria, Albania, Arabia, Andorra, Anjouan, Archangel, Angola (Portuguese), Anam, Armenia, Anatolia, Azores, Abyssinia, Afghanistan, Adana, Brazil 1873, Belgium, Bolivia, Bulgaria, Benin, Bessarabia, Benadir (Italian), Borneo, Babylonia, Bali, British Honduras, Bavaria, Bosnia, Bokhara, Balaerics, Bukowina, Canada, Cape Verde Islands, Canal Zone (people are mostly Latin-Americans, using metric units), Ceylon, Curicao, China (the Chinese government has definitely decided gradually to turn its 426,000,000 to exclusive use of meter-liter-gram—it is the standard of 28 ports now), Chili, Colombia (as New Granada 1863), Costa Rica, Croatia, Czecho-Slovakia, Cuba, Caroline Islands, Cambodia, Cochin China, Dutch Celibes, Canaries, Cyprus, Corsica, Crete, Denmark, Dalmatia, Dahomey, Dobrudja, Damaraland, Egypt, Ecuador 1856, Formosa, Faroe Islands, Filipines, French India, French Oceania (Tahiti, etc.), Gabon (French)), Guadelupe, Grand Bassum, Germany 1871, Greece, Guatemala, Greenland, Guiana (French), Guiana (British), Guiana (Dutch), Guinea (Portuguese), German East Africa, German West Africa, Togoland, German Borneo, Guam, Hungary, Hongkong, Holland, Haiti, Honduras, Herzegovina, Italy, Iceland, Ivory Coast (French), India (India is the source of origin of the decimal science of positional decimal arithmetic; her standards of weights and measures are metric units—the Series 1,000 grams; the Ser of water is the liter exactly), Indo China (French), Japan, Java, Jugo Slavia, Juan-Fernandez, Kamerun, Korea, Kongo (French), Kongo (Belgian), Kongo (Portuguese), Khiva, Kurdistan, Lithuania, Liberia, Luxemburg, Lombok, Marshall Isles, Mayotte (French), Madagascar, Miquelon, Manchuria, Mongolia, Mesopotamia, Mexico 1856, Morocco, Moravia, Montenegro, Mauritius, Monte Carlo, Martinique, Madura, Molucas, Macao, Madeira, Malay States, Namaland, Norway, New Guinea, Nicaragua, New Caledonia, Nigeria, Newfoundland, Oro (Spanish), Odrar, Peru, Poland, Palestine, Paraguay, Patagonia, Panama, Porto Rico, Portugal, Pescadores, Russia, Ruthenia, Rhodes, Reunion, Revieres-du-Sud, Rumania, Siberia, Salvador, San Domingo, Serbia, Spain, Switzerland 1875, Samoa, Samoa (German), Samos, Sardinia, Sicily, Siam, Sumatra, St. Lucia, Smyrna, Syria, St. Pierre, Sahara, Senegal, Senegambia, Somali, Somali (Italian), Straits Settlements, Tonquin, Tripoli, Tunis (French), Tunis (Italian), Timor Islands, Turkey, Turkestan, Tibet, Trebizond, United South Africa, Uruguay 1862, Ukrania, Venezuela, Virgin Islands, W. Africa (French).

Why Research Training Develops Successful Executives

In a recent editorial article we discussed briefly the desirability of training engineering students in research, our argument being that such training not only inspires the student as no other training does, but develops the habit of searching for information and of putting the information to use. In addition to these merits, research training leads ultimately to a higher standing of engineers in the eyes of employers, and thus to higher remuneration.

In a recent paper by a British educator this last named advantage of research training was strongly emphasized. The writer pointed out that the research students of German universities had been able not only to secure higher salaries after graduation than ordinary graduates receive, but also had risen to higher executive positions. He attributed the phenomenal pre-war growth of Germany's manufacturing industries to the research training that so many of the technical students had received. This had been asserted many times before, but this English educator brought out the rarely considered fact that research training leads to high executive positions more often than does techincal training of the kind common in Great Britain, and, we may add, in America.

Young men are naturally fond of exploring new lands. By giving them research problems to solve, their instinct for exploration is aroused and they work with an enthusiasm that seldom is seen when they are engaged in solving the old, set problems of the text books. Enthusiasm for study, as every educator will admit, is the great desideratum. Indeed, it may be said to be the ultimate goal of all formal education. But to be of greatest utility, enthusiasm for study must become habitual. It must not be of the kind that is kindled only in the presence of a great teacher. It must be self-kindling and therefore enduring. This sort of enthusiasm is the product of research training.

Having become habituated to search for facts, to classify, to analyze, to draw inferences, and to put the conclusions to useful application, the research graduate enters a technical career with delight. But if he is directed into a business career, his delight is apt to become the less, for he speedily sees that all mental work of the highest order involves research. There is not less call for exploratory study in business than in professional life. Only an ill-trained man imagines that business is necessarily a dull occupation, or a mere money-grubbing affair. Business, like professional work, is exactly what the individual makes it to be. If it is approached in a purely routine fashion, it will be found to be dull and uninteresting.

If, however, it is approached as if it were a scientific problem or rather an endless procession of scientific problems, then business becomes as great a "game" as the most interesting of professional problems.

Training in research serves to convert every difficulty or trouble into a problem to be scientifically solved. It makes old things new, and converts life's work into a perpetual exploring expedition. Shall we wonder, then, that German research students have so frequently become the heads of large industrial corporations?

U. S. Loses Lead in Building Ships.—Great Britain once again is the leading shipbuilding nation. Statistics issued by Lloyd's Register of Shipping show that on July 1, 1920, there was under construction in the United Kingdom more than 1,000,000 gross tons in excess of the July 1, 1919, figure, while all other countries combined, exclusive of the United States, showed an increase of more than 100,000 tons. The American aggregate of 3,874,000 tons a year ago has now declined to 2,105,000 tons. Today, therefore, the United States is building 1,172,000 tons less than the United Kingdom, whereas, a year ago, America led by 1,350,000. How the United States and the United Kingdom have stood since the period of the armistice in relation to tonnage of all types under construction is shown by the following table giving the totals at the end of each quarter in gross tons:

	United States.	United Kingdom
Sept. 30, 1918	3,382,000	1,713,000
Dec. 31, 1918	3,645,000	1,979,000
Mar. 31, 1919	4,185,000	2,254,000
June 30, 1919	3,874,000	2,521,000
Sept. 30, 1919	3,470,000	2,816,000
Dec. 31, 1919	2,966,000	2,994,000
Mar. 31, 1920	2,572,000	3,394,000
June 30, 1920	2,105,000	3,578,000

Distribution of the construction of steel steamers in the past two quarters has been as follows, in gross tons:

	July 1	March 1
United Kingdom	3,563,251	3,379,731
United States	2,052,916	2,418,158
Other countries	1,955,771	1,894,880
Total	7,571,938	7,692,769

377,000 Buildings Erected in Larger Cities in 1919.—According to reports received by the U. S. Geological Survey from 114 larger cities of the country the number of building permits issued or buildings erected in these cities in 1919 was 309,551, as compared with 173,635 in 1918, an increase of 135,916, or 78 per cent. The cost of operations in 1919 was $1,130,817,591, as compared with $369,252,315 in 1918, an increase of $761,565,276, or 206 per cent. If the operations in the remaining cities from which the Geological Survey usually receives statistics of building operations show a proportionate increase, the number of permits issued or buildings erected in 1919 was about 377,000, which would cost about $1,300,000,000, so that the record for 1919 was the highest yet reached in the building industries in these cities in both the number and the cost of operations. The year of the next highest record was 1916, when 317,761 operations were reported, which cost $1,016,276,549.

A Code of Ethics for Engineers

In his July 3 issue the editor of the Mining and Scientific Press makes a few somewhat pertinent remarks regarding the sense of 14 articles of the tentative draft of a "code of ethics," prepared by a special committee of the American Society or Municipal Engineers. We quote from the editorial as follows: "To some it may seem futile to attempt to improve upon the familiar set of ten admonitions that were first promulgated on Mt. Sinai and equally so to attempt to legislate morals into people either by imperial or democratic edict. Yet, if a formal code of ethics we must have, let it be brief and to the point. We venture the opinion that some of the articles proposed by the Mechanical Engineers are of too little importance and that some are either inconsistent or not clearly expressed. If they be deleted or revised the essential parts will gain emphasis, and the value of the entire code will be increased. For example, Article 8 reads: 'He should satisfy himself before taking over the work of another consulting engineer that good and sufficient reasons exist for the change.' There can be but one 'good and sufficient reason' for a change other than the voluntary resignation of the first engineer himself. That reason is the dissatisfaction of the client who is presumably the man that foots the bills. Few mining engineers would care to continue in the capacity of consultant to a company that wanted to get rid of them, but that was unable to do so because ethics, or etiquette, would prevent another engineer from taking up the work. Why engineer No. 2 should pass judgment on the motives of the employer or client in seeking the services of another consultant is hard to see, either from an ethical, or from any other codic viewpoint. Article 9 declares that 'He must base all reports and expert testimony on facts or upon theories founded only on sound engineering principles and experience.' In the name of common sense on what else could an intelligent man base his expert opinion?" Indeed, we must assume that all engineers have intelligence; and even if some lack it, the mere fact does not make them guilty of any breach of ethics. Certainly we cannot declare 'unethical,' or heretical, one group of engineers because their conclusions based on the identical set of facts diverge widely from those of another group. Judged by that standard every lawsuit involving expert testimony from engineers would produce material for the consideration of the proposed Standing Committee on Professional Conduct. Article 10 reads: 'He must not regard as his own any information which is not common knowledge or public property, but which he obtained confidentially from his client or while engaged as an employe. He is, however, justified in using such data or information in his own private practice as forming part of his professional experience.' These two ideas are perhaps not flatly contradictory, but they read as if they were. If they mean anything it is that an engineer should not publish confidential information obtained during the performance of his professional duty without the consent of his client. Next is Article 11, which says 'He should do everything within his power to prevent sensational, exaggerated, or unwarranted statements about engineering work being made through the public press. First descriptions of new inventions, processes, etc., for publication should be furnished only to the engineering societies or to the technical press.' In view of the proclivity of the 'public press,' which presumably refers to the daily newspapers, to gather sensational and exaggerated, if not unwarranted, statements, the engineer who fulfilled the letter of this mandate would have little time for his professioanl work. As to the second injunction, the impress of a spirit kindred to our own is manifest. We appreciate the motive, and are duly grateful; but is there any essential obligation for the engineer to do either of these things in order to be 'ethical'? Would the failure on his part to do either be a reasonable excuse for disciplinary action on the part of the national engineering society to which he happened to belong? We mention these things simply to illustrate the point that there has not been exercised enough care and discrimination in the preparation of what is expected to be an enduring code. The various societies may well formulate a statement of essential principles governing the professional conduct of their members, but they should take time to decide just exactly what those principles should be. The Decalogue was written on stone."

Design of Reinforced Concrete Slabs with Saw-Tooth Top

By J. W. PEARL.

Having failed to find formulas for the design of steps, stairs or grandstand slabs of concrete reinforced transversely, in many publications examined, the author contributes the method developed below to the literature upon that special subject.

Standard notation will be used where it will apply and other symbols used are as shown in Fig. 1.

The compressive stress on a small area, $\delta y \delta x$, at a distance y, above the neutral will be $f_c \delta y \delta x . y . kd$ and its moment about the neutral axis will be $f_c \delta y \delta x y^2 kd$.

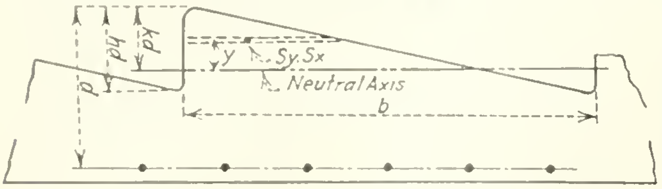


Chart for Use in Design of Reinforced Concrete "Saw Tooth" Slab.

On a narrow strip across the step parallel to and at a height y, above the neutral axis the stress

$$= f_c \frac{b(kd - y)}{hd \times kd} y \delta y \text{ and its moment} = f_c \frac{b(kd - y)}{hd \times kd} y^2 \delta y$$

The total compressive stress in the concrete then

$$= f_c \frac{b}{hd} \int_0^{kd} \left(y - \frac{y^2}{kd} \right) \delta y = f_c b\overline{kd}^2 / 6hd. \quad \ldots\ldots\ldots\ldots (1)$$

The moment of the compressive stress in the concrete, with reference to the neutral axis, is

$$= f_c \frac{h}{hd} \int_0^{kd} \left(y^2 - \frac{y^3}{kd} \right) \delta y = f_c b\overline{kd}^3 / 12hd. \quad \ldots\ldots\ldots\ldots (2)$$

Equations (1) and (2) are exact for cases in which kd is equal to or less than hd, and will in other cases in ordinary practice err slightly on the side of safety when hd is assumed to be equal to kd.

The total tension in reinforcing bars $= Af_s$. A will be taken as equal to p, bd and $E_s = 15\ E_c$ and there results—

$$Af_s = 15 f_c . \frac{1 - k}{k} . pbd = f_c bkd^2 / 6hd. \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

which reduces to $90\ ph\ (1 - k) = k^3$.

It will now be convenient to use the ratio of kd to hd $= k \div h$ and there results—

$$K = -45p \frac{h}{k} \pm \sqrt{99p \frac{h}{k} + \left(45p \frac{h}{k} \right)^2} \quad \ldots\ldots\ldots\ldots (4)$$

By substituting rational values for p and $k/_h$ in equation (4) the values of k as given in table and chart are determined.

TABLE OF VALUES OF K.

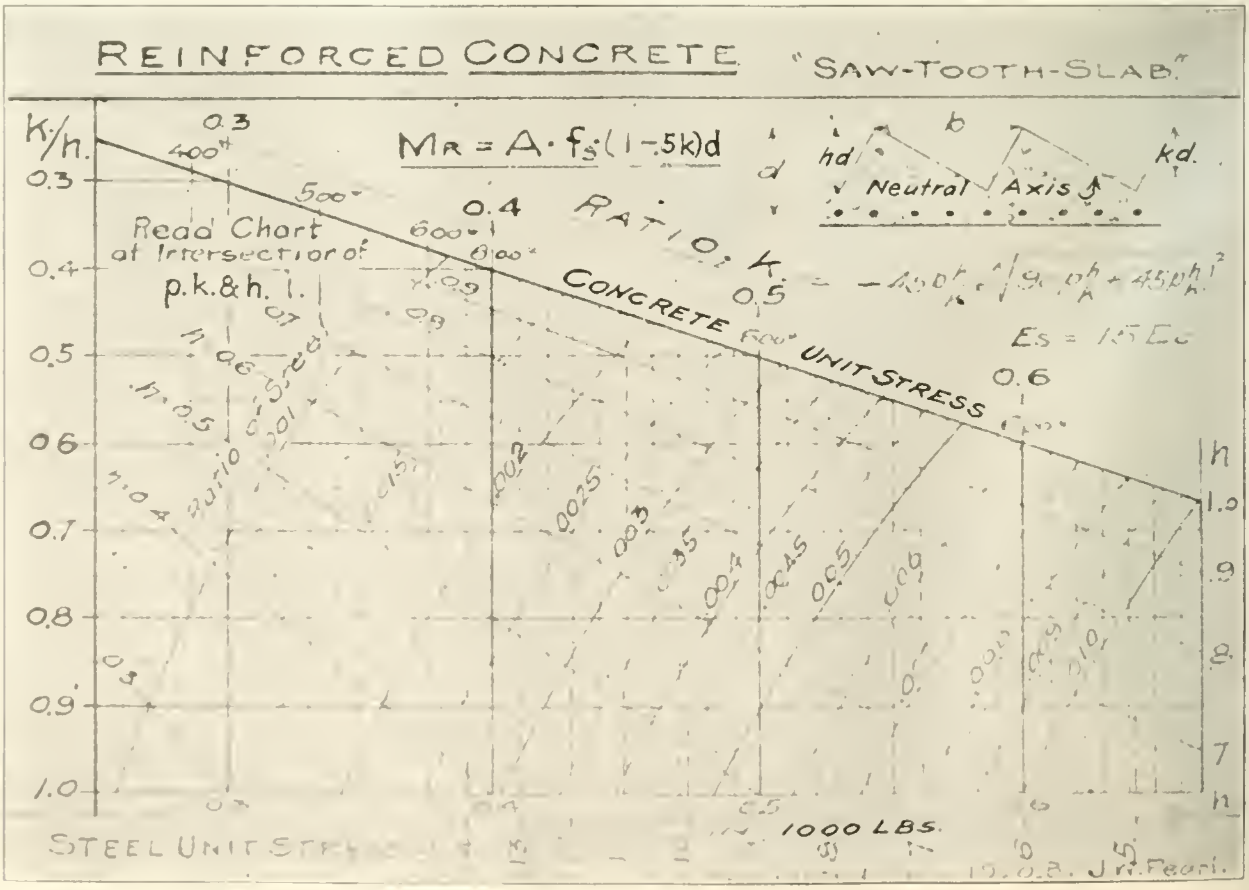
Steel Ratio A ÷ bd	Ratio k ÷ h 0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
.001	.42	.375	.34	.32	.30	.28	.27	.26
.0015	.48	.44	.40	.375	.35	.33	.32	.31
.002	.53	.48	.44	.42	.39	.375	.36	.34
.0025	.57	.52	.48	.45	.43	.41	.39	.375
.003	.60	.55	.51	.48	.46	.44	.42	.40
.0035	63	.58	.54	.51	.48	.46	.44	.42
.004	.65	.60	.56	.53	.50	.48	.46	.44
.0045	.67	.62	.58	.55	.53	.50	.48	.46
.005	.69	.64	.60	.57	.54	.52	.50	.48
.006	.72	.67	.63	.60	.57	.55	.53	.51
.007	...	...	.66	.62	.60	.58	.56	.54
.008	...	...	...	.65	.62	.60	.58	.56
.009	...	...	...	.67	.64	.62	.60	.58
.010	...	...	...	...	.66	.64	.62	.60

In a trial section for a stair or theater floor the values b and hd will be known from the plans; when depth d is assumed the value of h is determined and by reading along the line h various values of p and k will be located at the common point of intersection of lines p, k and h.

For every point selected the approximate unit stresses in concrete and steel may be read at the top and bottom of the chart and the moment of resistance determined in the usual manner.

For cases requiring exact results, either two of the three functions p, k, h, may be selected from the chart and substituted in equation (4) and the result determined to as many decimal places as desired.

A word of caution is necessary. Novices but partially in-



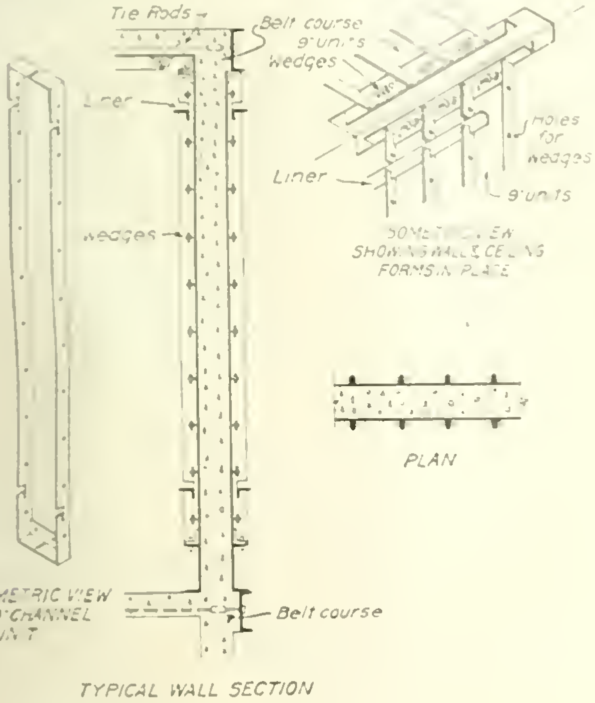
formed on the theory of reinforced concrete and the internal stresses in this valuable but complex material should not attempt to or be permitted to design work from this chart.

Systems of Monolithic Concrete House Construction

As a part of its report at the last national conference on Concrete House Construction the committee on monolithic concrete houses submitted a description of various systems of molds used in constructing this type of building. The matter following has been taken from the recently issued Proceedings of the Conference.

Lambie System.—Lambie forms are manufactured from 6-in. shipbuilding channels and standard [illegible] channels of various lengths together with liner angles, [illegible] plates, inside and outside corners, collapsible [illegible] and belt course.

The standard channel units are 7 ft. [illegible] long, punched on flanges and on ends so that they can be clipped together in a horizontal or vertical position. Any dimension in multiples of 3 in. can be obtained by combining 6-in. and 9-in. units. Height of ceiling in multiples of 3 in. can be obtained by using the units vertically and horizontally and openings for doors and windows can be made at any point and of any size. Porches and areaways are formed with the body of the house.



TYPICAL WALL SECTION

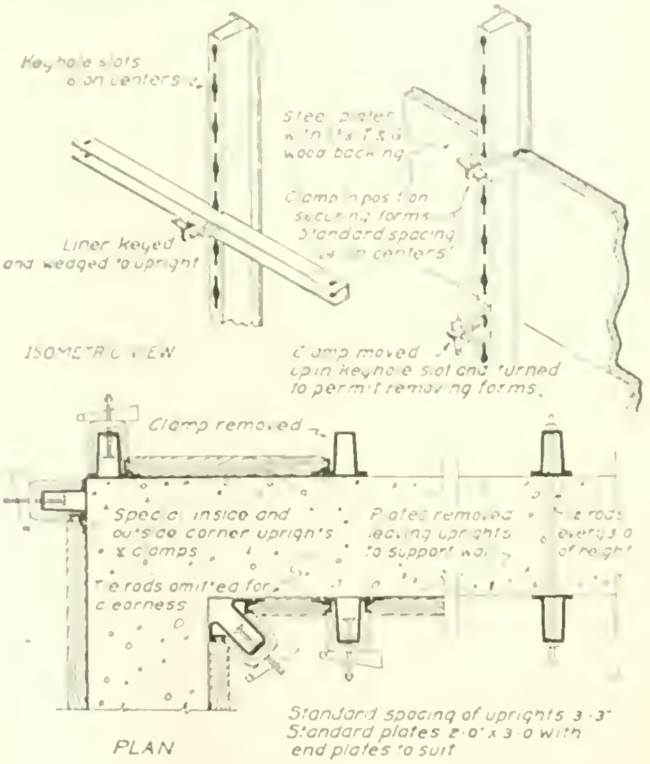
Lambic System; Details of Form Units.

The individual channel units are secured to each other with clips and wedges. A special angle-iron liner is then inserted in the notches in the channel iron to insure a perfectly straight surface. At the same time as the wall forms are erected the forms for the floor or roof above are put in place. Then both side walls and floors are cast. When the forms for the basement are erected their tops are attached to a special member called the belt course, which holds the forms in place, and are cross-braced by steel rods extending from one side of the house to the other. These rods remain in place after floors are cast and serve as reinforcing for the floor. The belt course is also placed at the second story floor line and forms used for first floor are used throughout the building by raising them from story to story. The regular channel units are used for forming the floors.

Hydraulic Steelcraft Forms.—These forms consist of light pressed steel U-shaped vertical liners and horizontal ribs supporting steel form plates backed with wood. The edges of the wood backing are clad with light steel plates. Keyhole slots in the back of the vertical lines enable the horizontal ribs to be clamped on by means of a key, wedge and U-clamp.

In erection, the framework of ribs and liners is erected and aligned. The plates may be left off while reinforcing steel is being placed or they may be removed at any point to give access to the forms for cleaning or other purposes. Floors and roof slabs are constructed by using the same equipment as for walls.

These forms can be erected with any labor available as skilled labor is not required. No cutting or fitting is done. Forms are automatically spaced by the liners. All fastenings are of a quick acting wedge type which requires only driving up the wedge with a hammer.

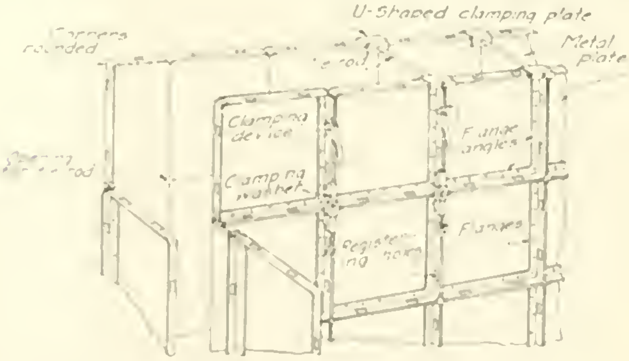

Keyhole slots 6" on centers
Steel plates with 1/4" x 3/8" wood backing
Clamp in position securing forms. Standard spacing 1'-6" on centers
Liner keyed and wedged to upright
ISOMETRIC VIEW
Clamp moved up in keyhole slot and turned to permit removing forms.
Clamp removed
Special inside and outside corner uprights & clamps
Plates removed leaving uprights to support wall
Tie rods every 3'0" of height
Tie rods omitted for clearness
PLAN
Standard spacing of uprights 3'-3"
Standard plates 2'-0" x 3'-0" with end plates to suit

Hydraulic Steel Craft System; Details of Forms.

No part is heavier than one-man size. With one set of forms an ordinary 2-story 6-room house with basement can be erected at the rate of one house every 8 working days.

The Schub System.—The Schub system consists of plurality of metal plates, generally square in form. These plates are flanged on all outer edges with angle-irons. To accommodate variations in length of structures, shorter plates are used, these being of the same height and construction as the common square molds. By setting these short plates or molds on edge varying heights can be obtained.

Flanges have two holes on each side, one located near each corner, matching corresponding holes in adjoining plates. Through any pair of holes the pin of a lever handled V-slotted clamp is inserted and when the handle is pushed down, the flanges of adjoining plates or molds are drawn tightly and firmly together within the V-slot of the clamp.

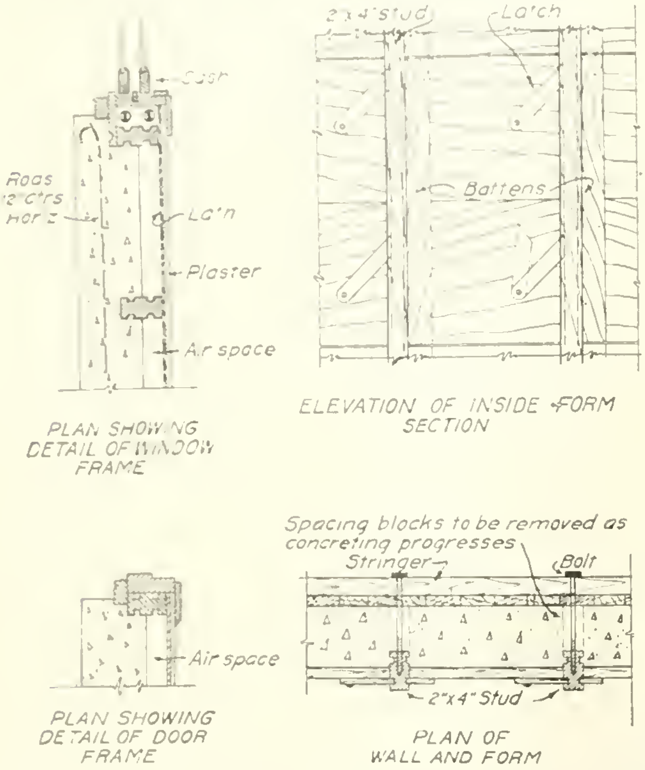


Schub System; Details of Forms.

Sleeves, short lengths of pipe, slightly less than the width of the finished wall in length, are used to separate the inner and outer molds and also permit bolts or rods to pass through for drawing the forms together. A cone-shaped washer is placed at each end of the sleeve, thus increasing the length to the exact width of wall desired. At the common corner of four mold plates the bolt is inserted between the rounded corners of the plates through the sleeve and clamping-washers placed on each end of these bolts. When the top tier of forms is reached a loosely placed U-shaped washer is placed over the end of each rod which locks or clamps the four plates together at the corner.

When forms are removed, the washers on the ends of the sleeves are pried out and the holes filled with cement mortar. When adapting plates to corner construction an angle iron is placed or fastened to the edge of the common square plate, thus turning the plate at right angles.

The Fellgren System.—In the Fellgren system a framework is erected as for the ordinary frame construction. Studs are grooved on the 4-in. face and properly spaced for furring for lath. The grooves anchor the studs into the concrete and also support the inner mold boards, which occupy the space between studs. These mold boards are about square in shape and are held at any desired height by latches fitting into the grooves in the studs. The outer forms are built of 1-in. lumber connected so as to form units by two stringers. These units are about 2 ft. in height and any desired length, and are fastened to the studding and held at proper distance by lag screws and separators. After any layer of concrete has been placed and has become sufficiently hard, the lag screws are removed and the outer forms moved to the position immediately above. The holes made by the lag screws are filled with cement mortar when forms are removed. The walls are generally about 6 in. thick and $1\frac{1}{2}$ in. of the studs extends beyond the concrete on the inside face of the wall. This provides an air space between the concrete wall and the lath-and-plaster, which serves as insulation. The exterior surface of the concrete walls can be finished in any manner desired. In this system concrete work has so far been confined to wall construction, but the inventor, C. W. Fellgren, has developed the system for use in constructing floors and roofs.



PLAN SHOWING DETAIL OF WINDOW FRAME

ELEVATION OF INSIDE FORM SECTION

PLAN SHOWING DETAIL OF DOOR FRAME

PLAN OF WALL AND FORM

Fellgren System; General Details of Forms.

Ingersoll System.—This method is more particularly adapted to industrial houses where several units of similar design and plan are to be built. These might be called standardized houses. Footings and basement floor are placed in one operation, after which form work for the entire house is erected at one time and the house is completely cast during one operation.

An interior rigid framework for the two stories is first erected. This framework consists of columns continuous throughout all stories and held in their positions rigidly by trusses. On the supporting framework are hung the forms which mold the concrete of the outside and partition walls, the stairs, floors and roof, the cornice, brackets and other ornamental work.

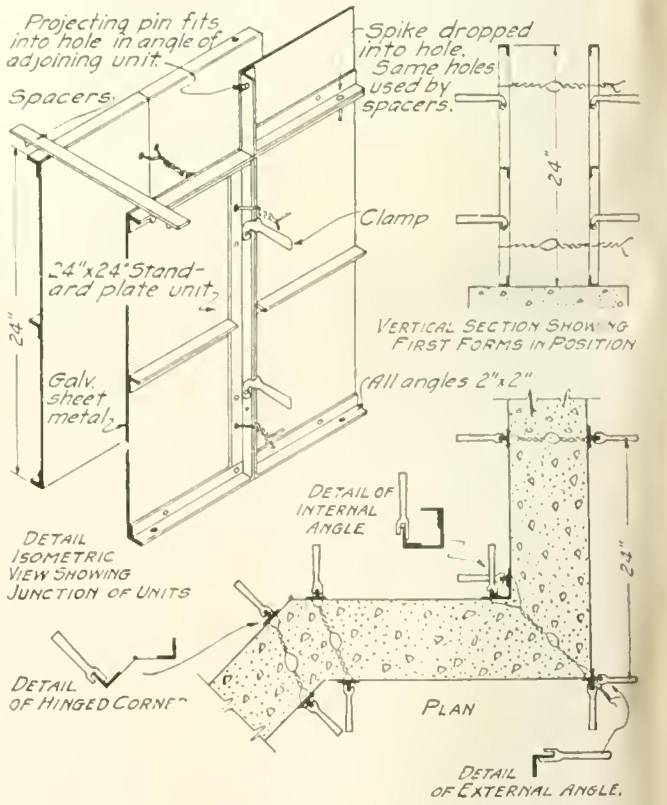
The forms are kept from bulging by means of iron bars which extend through forms and wall. Wooden separators are placed between the inside faces of the forms, so that the entire form structure is absolutely rigid before any concrete is placed.

All reinforcing steel is placed in the form before the house is cast. The vent and soil pipes, electric conduits, metal flue lining for the chimneys, window frames, door bucks, furring strips, nailing blocks, etc., are also set in place before the concrete is cast.

The concrete is placed through window or door openings on the lower story, thus eliminating the danger of separation of the aggregate from the cement, which might occur if the concrete for the entire house were placed from the roof.

Metaforms System.—The Metaforms system of forms is based on a 24-in. square, light metal unit. Special units of dimensions graded down every 2 in. to a 2-in. plate permit the construction of walls of any multiple of 2 in. in length, and one special 3-in. plate used in conjunction with these enables a wall to be built any odd number of inches in length.

The unit consists of a galvanized iron sheet with a 1-in. by 1-in. angle riveted to all sides, and an additional angle across the middle of the plate to act as a stiffener. The top and bottom angles are provided with holes opposite each other, in which spikes are dropped to maintain vertical alignment. On each side of the side angles there are small pins projecting ⅛ in., near the top and bottom, which fit into corresponding holes in the angle of the adjoining unit, thus maintaining horizontal alignment. One of the side angles has pinned to it two malleable iron clamps which clamp the flanges of adjoining units securely together. These units are wired in a manner similar to wood forms, holes being provided in the plates for that purpose. Stay rods, adjustable to the thickness of the wall, hold the plates apart.


Projecting pin fits into hole in angle of adjoining unit.
Spacers
Spike dropped into hole. Same holes used by spacers.
24"
Clamp
24"x24" Standard plate unit
24"
Galv. sheet metal
All angles 2"x2"
24"
Detail of Internal Angle
Detail Isometric View Showing Junction of Units
Detail of Hinged Corner
Plan
Detail of External Angle.

VERTICAL SECTION SHOWING FIRST FORMS IN POSITION

Metaforms System; General Details of Forms.

A 1-in. angle with clamps is provided for outside corners of the wall. The inside corner connection is a 2-in. angle having smaller angles riveted to the extremities of the legs. A hinged corner with clamps can be used for non-rectangular buildings or bay windows.

Morrill System.—The standard Morrill form unit is a plate 24 in. square, weighing about 30 lb. Another size is an oblong plate 16 in. by 48 in. Plates are punched from the sheet and flanged by pressing in a die. The plates are secured together, flange to flange, with clips and steel wedges.

Spacers and wedges [illegible] of the forms rigidly in place. To avoid the [illegible] plates to fit different size buildings, the [illegible] lap by [illegible] obtaining any dimensions desired.

The molds may be used in [illegible] according to the work to be done:

1. The plates may be set up [illegible] story cast at one operation.
2. The two-tier "swing-up" method [illegible] employed.
3. The one-tier "move-forward" [illegible] be used.
4. For the small job the two [illegible] forward" outfit is most suitable.

The first method allows the casting [illegible] story of a house in one day, using the forms [illegible] story house. The second utilizes a [illegible] and the walls for the average two-story cottage [illegible] using the forms nine times to construct [illegible] high. The third—the one-tier "move-forward" [illegible] only a few pairs of plates, and it is possible [illegible] to have from 10 to 20 houses going on at the same time.

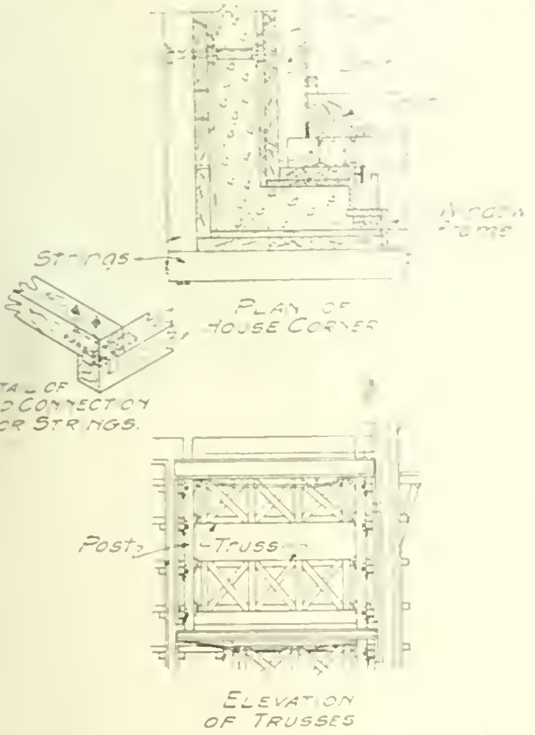
In the two-tier "swing-up" method [illegible] and lower tiers of plates, both inside and out, are secured together [illegible] multiples of 10 to 15. These two tiers of plates are connected from their center points by hinge arms. The two tiers of plates are set up on the foundation and filled with concrete and allowed to set a few hours. The lower tier is released by driving out locking wedges. This allows the plates to hang free and to swing up, revolving through a half circle on the hinge arms connecting the centers of the pairs of plates.

In this way from 40 to 60 sq. ft. of wall form is set in one operation, and the plates are swung up, tier after tier, until the top of the wall is reached. Then the connecting wedges are driven out and the plates are ready to move to the next job.

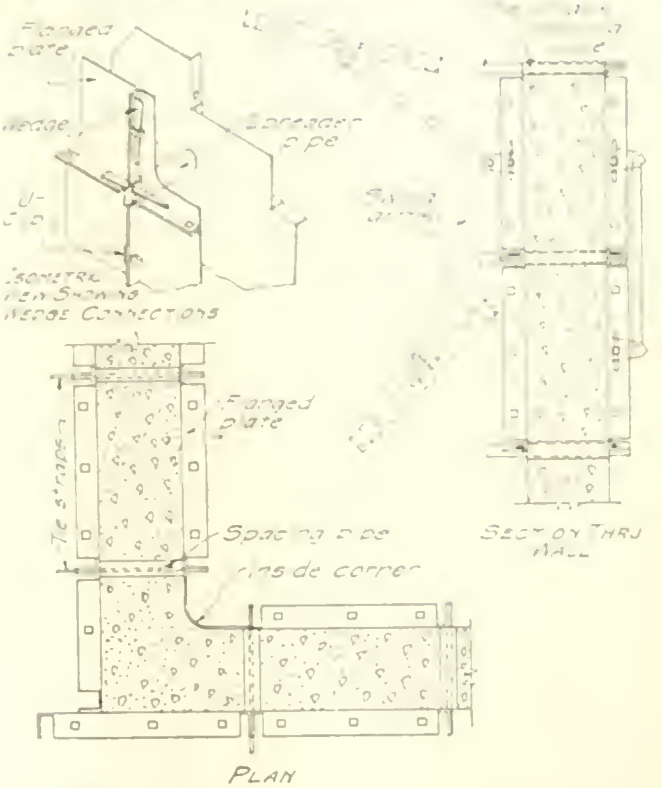
By the "swing-up" method, three men can raise and set in place 50 sq. ft. of form in less than three minutes.

In using the one-tier "move-forward" method a few pairs of flanged plates are set up where the wall is to be molded. When the molds have been filled with a "quaky" mix the first molds filled can be removed and passed forward to a new position along the wall.

The two-mold "swing-forward" method employs the smallest of the Morrill Wall Molding outfits. By this method, the wall is molded in place block by block. The concrete must be stiff enough to stand alone so that the side plates may be stripped at once or some delay must be allowed for the concrete to harden sufficiently to stand. With this outfit corner angle rods are used to keep the wall straight and plumb. The outfit can be carried on a wheelbarrow.



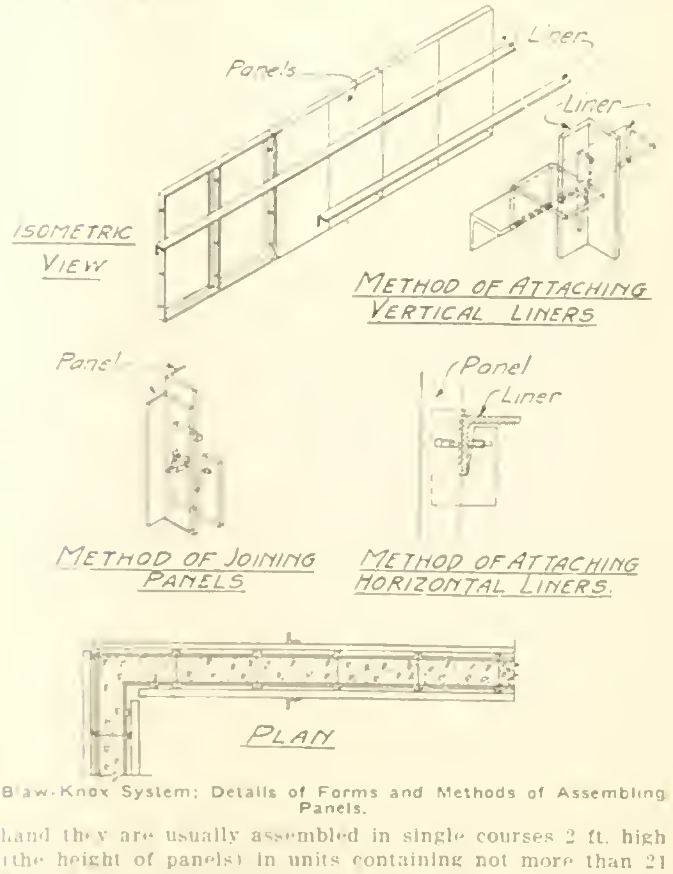
Ingersoll System; Details of Form at Window Openings and Method of Supporting Floor and Wall Forms.



Morrill System; Details Showing Application of Forms.

Blaw-Knox Forms [illegible] sheet metal panels [illegible] with steel angles on all four edges and [illegible] panels lap and corner [illegible] wall dimensions and thickness.

In assembling, the forms are secured to each other by means of wedge keys that are interchangeable and are slotted. The wedges are inserted in holes in the form flanges and a second wedge is driven into the slot of the first wedge, locking the forms securely. When forms are to be shifted by hand they are usually assembled in single courses 2 ft. high (the height of panels) in units containing not more than 21 sq. ft. of surface. The forms are then fastened to horizontal liners ordinarily 11 ft. 6 in. long.


Panels
Liner
Liner
Isometric View
Method of Attaching Vertical Liners
Panel
Method of Joining Panels
Panel
Liner
Method of Attaching Horizontal Liners.
Plan

Blaw-Knox System; Details of Forms and Methods of Assembling Panels.

The horizontal liner is attached to the forms by means of small plates slotted to take the leg of angle liner. These plates have an integral latch piece which is inserted in corresponding flange slots in the form panels. When horizontal angle liner is placed in the slot in the plates the latch piece is drawn up tightly and liner is made secure with wedge key. The forms are now securely fastened and aligned.

Two to five courses of assembled sets can be used by spacing one above the other, and these are joined by means of vertical liners placed 6 to 8 ft. centers, which are fastened to the horizontal liners by means of plates similar in principle to those described.

Where a large amount of concrete is to be placed at one time wire ties are used to prevent spreading. When using single tier forms, clamps are used at top of forms to prevent spreading of forms.

Specially designed sheet metal forms are best adapted to floor and roof construction

Breaking Up Concrete Foundations with Dynamite

In enlarging the power plant of the International Corporation of Mulberry, Fla., some heavy concrete foundations for boilers and a 175-ft. stack were installed. After the concrete had been allowed to set for about four weeks it was found that the boiler foundations had soft spots in them, and accordingly it was decided to tear out the concrete and rebuild. The stack foundation also was condemned. The narrow boiler foundation walls were easily removed but the stack foundation was a more difficult problem. This foundation was of concrete 7 ft. deep, and poured in three runs. The bottom was 22 ft. in diameter, second pouring 17½ ft., and third or top pouring 16 ft. It was proposed to blast out the concrete with dynamite, but great care had to be taken in doing this as within 50 ft. of the foundation there was a million dollar Diesel power plant and 15 ft. away a $20,000 hoist which could not be moved. New boilers and their fittings also were scattered around.

Holes were drilled 30 in. deep and 30 in. apart (staggered) for the first blast. This depth took holes just 2 in. below level of last pouring. These holes were loaded with ½ lb. of 40 per cent straight dynamite and fired electrically. Straight dynamite was used on account of its quicker action so as to get this splitting between layers and between holes.

Excellent results were obtained from this shot, the concrete breaking in blocks on the 2-ft. 4-in. level and between holes and was easily lifted out with the steam hoist. The second holes were drilled 3 ft. apart and 3 ft. deep (staggered). The depth of these holes was increased so as to penetrate the first layer 6 or 8 in., to get a shattering effect on this bottom layer to as great a depth as possible without breaking through. The blast broke the second layer nicely and shattered the bottom layer to about half its depth

Before each blast was fired, the foundation was carefully covered with heavy timbers and these anchored with railroad ties to prevent any of the blasted material from getting away.

Ship Building in United States. On July 1, according to Lloyd's Register of Shipping, 366 steel steamers were under way in America, representing an average per ship of 5,600 gross tons, as against 4,012 tons for the 888 British vessels and 2,585 tons for the 655 building for the rest of the world. Only 29,000 tons of wooden vessels are now being built in this country. A year ago 120,000 tons were under construction here. More than 97 per cent of the American total now building is steel steamers. The following table shows the distribution by districts in gross tons for the quarter just ended and the previous one:

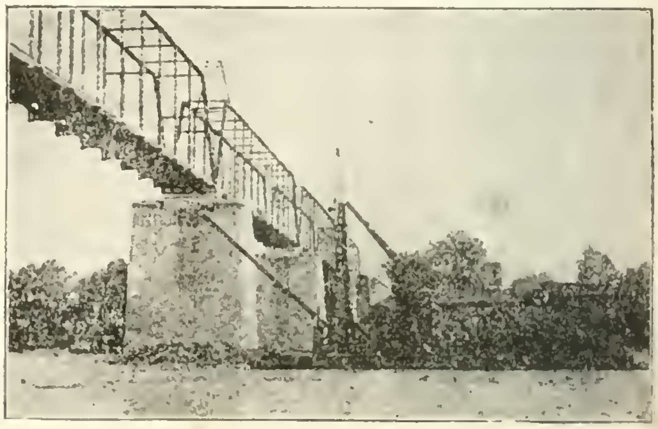
	July 1.	March 1.
Atlantic Coast	1,352,750	1,585,827
Gulf ports	181,841	180,793
Great Lakes	95,201	173,375
Pacific Coast	423,124	178,163
Total	2,052,916	2,118,158

Convicts to Build Their Prison. Convict labor will be used in the construction of a $250,000 state prison to be erected at Speigner, Ala

Construction Methods for Rapid Renewal of Tennessee Bridge of Southern Ry.

A hurry-up job of bridge construction on the Southern Ry. at Chattanooga, Tenn., was recently brought to a successful conclusion. The old spans were condemned by engineers of the U. S. Railroad Administration and an unusual amount of detouring was necessary in order that traffic might be handled successfully. The following details are abstracted from Railway Age of April 9, 1920.

The Old Bridge and Scheme of Renewal. The old Tennessee River bridge was built in 1878 for single track and consisted of six through, whipple truss spans 210 ft. long, one through span 261 ft., and one through swing span of 283 ft., all measured center to center of piers. The elevation of the base of rail was 65 ft. above low water level in the river, but only about 11 ft. above the maximum recorded high water. The ground level adjacent to the river, more especially on the south bank, is relatively low, so that long approach embankments were necessary. The substructure consisted of high stone masonry piers and T-abutments. Owing to the fact that the river bottom is bare rock, or rock covered with a relatively thin blanket of loose stone, clay and gravel, nearly all of the old piers were placed directly on the rock bottom



View of Old Span on Rebuilt Piers.

The renewal of this bridge to provide for modern train loads and double track was undertaken in 1916. It was decided to replace six of the old 210-ft. fixed spans by new ones of the same length, move the channel opening northward about 260 ft., so as to occupy the position of the old 261-ft. span and a part of the old north channel opening, and, in place of a draw span, provide a vertical lift span with a channel opening of 300 ft. clear width and arranged to raise sufficiently to give a vertical clearance of 50 ft. above high water. This involved provision for a new 230-ft. fixed span south of the lift span. It also required the widening of the two abutments and piers 4, 5, 6, 7, and 8 to accommodate the double-track superstructure, in addition to the construction of a new pier to carry the south end of the new lift span.

Work was prosecuted along this line during 1916 and part of 1917. The new pier was built and the old ones jacketed and extended and the abutments were widened by changing them into reinforced concrete counterfort wing abutments. Progress on the superstructure was carried to the point of fabricating and erecting the 300-ft. lift span, but omitting the elevating towers and machinery. To provide room for this span it was necessary to cut off about 53 ft. from the north end of the old draw span, provide a counterbalance and continue the span in operation in that shape. With the bridge in this condition, work was suspended in 1917 on account of the war and nothing further was done until the structure was ordered out of service in August, 1919.

Rapid Construction Imperative.—The emergency brought about by the order of the Railroad Administration called for a construction program that would insure the restoration of this river crossing at the earliest possible date. Aside from the interference with traffic, the recurrence of high water in the Tennessee River each winter made it necessary to institute a plan that would insure the completion of the substructure work before cold weather. After making estimates of the time necessary to fabricate and erect the truss spans required for the adoption plan and taking into account the fact that the erection falsework would be in use just at the time when the danger of high water was the greatest it was decided to make radical changes in the plans for the bridge. In place of the truss spans it was decided to provide deck plate girder spans, consisting, in general, of two 105-ft. girders for each of the 210-ft. truss spans and two 115-ft. girders for the 230-ft. truss span. This required the construction of six additional intermediate piers and the [illegible] of the entire substructure since the substitution of deck plate girders for the through truss spans made it necessary to raise the track grade by 5.62 ft. to meet the requirements of the War Department.

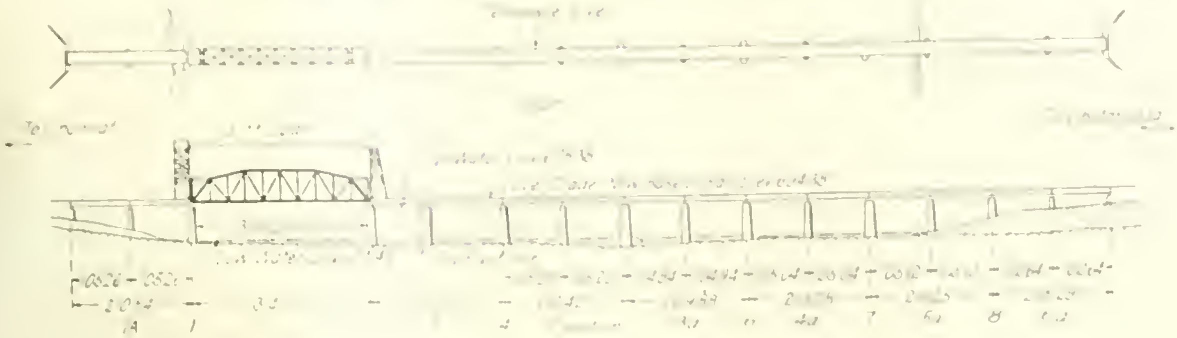
One effect of this was to require the embankment approaches to the bridge to be raised, the elevation at the north end being carried back 3,400 ft. and requiring the placing of 65,000 cu. yd. of filling and that on the south end going back 2,700 ft. with the use of 115,000 cu. yd. of additional embankment material.

Foundation Work.—New Pier 6-A was placed on 45 Raymond concrete piles with about 24 to 30 ft. penetration, their tops being embedded in a reinforced concrete footing slab 4 ft. thick. The other five new piers were carried to rock. Piers 2-A to 5-A, inclusive, were located directly in, or close to, open water, with the depth of water running up to about 25 ft., so that the construction and sinking of cofferdams or open caissons, which would have permitted excavation and concreting in the dry, would have constituted a difficult piece of work that would unquestionably have extended long into the high water season. As a consequence, it was decided to adopt the more expeditious plan of placing the concrete under water since the cofferdams or underwater forms required for this procedure could be built in much less time than puddled cofferdams.

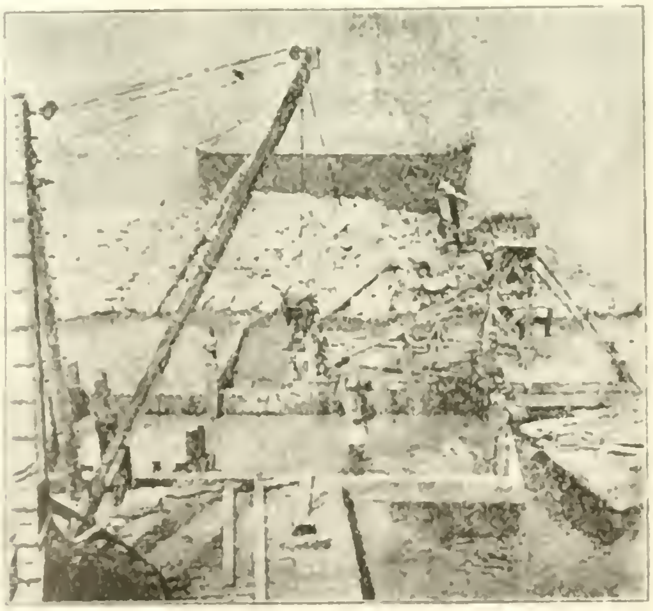
To this end the material overlying the rock at the site of each pier was removed with an orange-peel bucket, handled by a stiff-leg derrick mounted on a scow, the spoil being dumped back into the river at point within reach of the swing of the boom. On the rock surface thus prepared, a cofferdam 16.5 ft. by 40 ft. in plan was floated into position and sunk by weighting it with steel rails. This was composed of a single thickness of 12-in. by 12-in. timbers placed horizontally and drifted together. It was stiffened by other 12-in. by 12-in. pieces placed vertically inside the walls at the corners and at intervals between. To take care of any irregularities in the rock surface, sheet piling was driven inside the walls at places where the bottom of the cofferdam walls was not in contact with rock. The condition of the bottom and the position of the cofferdam with respect to the rock was carefully checked by a diver. As a further precaution, the outside of the open caisson was banked with the excavated material which was re-deposited against it by the grab bucket from the spoil piles. Before placing any of the concrete, a diver sealed the edges of the dam by placing sacks of concrete along the walls.

The concrete was deposited under water by a bottom-dump bucket handled by a stiff-leg derrick mounted on a barge. This bucket was filled with concrete from a small hopper and spout rig set up in a 10-ft. tower on a second barge, this hopper in turn receiving its supply of concrete from the mixing plant in a bucket by a 2,000-ft. cableway spanning from shore to shore. The building up of the mass of concrete under the water surface was checked carefully while the work was in progress with the aid of sounding rods and, when deemed necessary, through examination by the diver.

After the top of the concrete had been brought to within two feet of low water level forms were erected and the rest of the concrete poured inside them. As all of the new piers are of the same dimensions from the top to the cofferdam level, the forms, which were built in portable horizontal sections, could be readily reused on the several piers since the form section built for use at a given elevation on one pier would fit the same elevation on any other. The concreting in the forms was carried on in exactly the same way as for the portion that was deposited under water except that the bottom dump bucket was eliminated. In other words the spout and hopper rig was set up on top of the forms in a position where it was readily accessible to the cableway while the spout was long enough to deliver the concrete to any part of the pier.

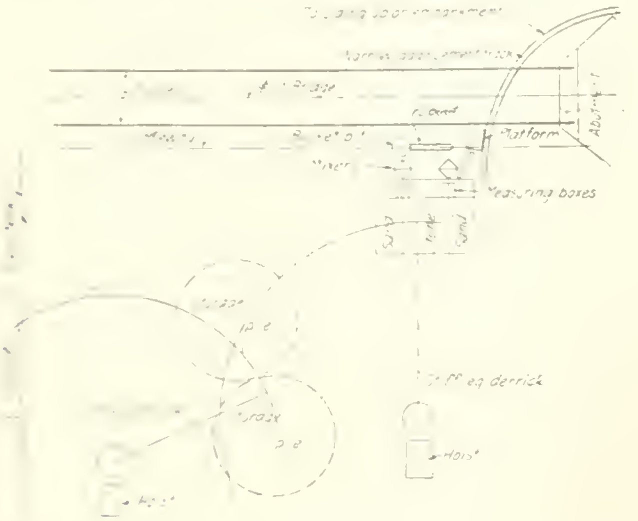

General Elevation and Plan of Bridge as Rebuilt.

A total of 4,700 cu. yd. of concrete was required for the new substructure work, all of which was supplied from one mixing plant located on the north bank of the river, just east of the bridge between the north abutment and Pier 1-A. All of this concrete was also delivered to the piers by the cableway which was located parallel to, and just clear of, the east line of the trusses of the bridge. The layout of the mixing plant is indicated in the sketch. Stone and sand were delivered at the river bank in barges. The cement arrived in cars set out on the bridge track just north of the abutment. Delivery of these materials to the plant involved the use of two stiff-leg derrick outfits with grab buckets for the stone and sand, and cars running on a narrow-gage track to take the cement from the railway cars down the end of the embankment to the mixers which stood at the foot of the abutment.


Cofferdam, Bottom Dump Bucket and Spout.

The mixing plant, which was in duplicate, was of the conventional type with overhead material pockets, one for stone in the middle with a smaller one for sand on each side. This arrangement made it possible to deliver these materials to two measuring boxes, each having separate compartments for sand and stone. These boxes stood on a working platform flanking the north side of the hopper structure which also afforded space for the water barrels and storage for a limited supply of cement sacks. The two mixers, a ½-yd and a ¾-yd., stood in front of the measuring boxes at an elevation low enough to receive the contents of the measuring boxes by gravity, while in front of the south mixer was a pit for the reception of the cableway bucket while it was being filled with concrete. This bucket received the charges of the south mixer by direct dumping, but a spout was required for the north mixer. The capacity of the plant was limited by the capacity of the cableway, which varied with the length of travel

Superstructure Work.—When the sub-structure was ready for the erection of the new superstructure, the old fixed spans were shifted westward on the piers as far as the length of the piers permitted so as to make room on the east ends of the piers for the erection of the girders for the east track.



Layout of the Concrete Plant.

The erection of the new superstructure proceeded progressively from both ends of the bridge. Each girder was set into place independently by a bridge derrick car, the girders of each span then being assembled by the cross and lateral bracing and decked to permit the advance of the derrick car to the next span. The last span to be erected was set complete by two derricks, one on each of the adjacent spans. With the erection of all of the girders for one track, it was possible to restore traffic on Jan. 20. However, several important steps in the work remained to be completed. The old truss spans had to be removed, after which the girders for second track were installed, although for the present this has been done only for the first five spans, including the lift span. The towers for the lift span have been erected and the lift span, which was erected to correspond to the old base of rail level, has been jacked up so that it comes to the newly established grade line.

The work on this structure was carried on under the general direction of E. M. Durham, Jr., until recently chief engineer of construction, Southern Railway, Washington, D. C., and under the more immediate direction of R. W. Jones, Jr., district engineer, Lexington, Ky., with P. R. Shields, resident engineer at the Bridge. G. H. Gilbert, bridge engineer, Southern Railway Lines West, had charge of the details of the steel work. The American Bridge Company, New York, had the contract for the steel fabrication and erection.

New Edition of Southern Pine Manual.—A revised and enlarged edition of the southern pine manuel of standard wood construction will shortly be published by the Southern Pine Association for distribution to architects and engineers throughout the country. New material incorporated in the manual includes a number of additional tables and formulas. Among these tables are some taken from the Carnegie Steel Co.'s handbook, also Hodgman's Surveyors' tables. The association also has purchased all rights for publication in this and succeeding editions of the manual of Mr. Benjamin E. Winslow's article on "Short Cuts in the Design of Roof Tree Houses." In order to take care of the needs of those already having copies of the old manual the association will publish a supplement containing the additional matter embraced in the new manual and send copies of the supplement to all such persons.

Effect of Rodding Concrete

Rodding of concrete consists in repeatedly pushing a pointed rod into the concrete. This has the effect of expelling the entrapped air and excess water, and of compacting the concrete. The beneficial effect of rodding was noted in a number of experiments made in 1917 by Mr. G. A. Parkinson, Assistant Testing Engineer, University of Texas. Since then, other tests have been made. Three series of tests are described in the following abstract of a paper by Mr. F. E. Giesech of the University of Texas, at the 23rd annual meeting of the American Society for Testing Materials.

In a series of experiments made at the University of Texas in 1917 to determine the physical qualities of concrete as determined by the relative quantity of cement, it was shown that excess water greatly reduced the strength of the concrete.

Realizing that in practical operations it is almost absolutely necessary to use enough excess water to make the concrete sufficiently fluid to be handled in wheelbarrows, or tubes, and so that it will flow readily into the forms, and between and around the reinforcing steel, and that such excess water reduces the strength of the concrete materially, the question arose, "What, if anything, can be done to prevent or reduce the injury to the concrete by the excess water?"

To study this question, Mr. G. A. Parkinson, Assistant Testing Engineer, University of Texas, made a number of experiments during the fall and winter of 1917 in which he prepared concrete with a considerable excess of water and, after the concrete had been deposited in the molds, removed the excess water by rodding the concrete. The results of these early tests were so very satisfactory that several series of tests have since been made, of which three will be described.

Tests to Determine General Effect of Rodding.—In June, 1918, eight groups of specimens, designated A, B, C, D, E, F, G, and H, respectively, were prepared. Each group consisted of six 6 by 12-in. cylinders.

In every case the composition by weight of the concrete was:

	Per cent.
Colorado River gravel P 1¼ in. R ¾ in.	29.7
Colorado River gravel P ¾ in. R ¼ in.	29.5
Colorado River sand P ¼ in. R No. 12	12.0
Colorado River sand, P No. 12 R No. 50	11.3
Colorado River sand P No. 50	3.1
Blend of two brands of Texas cement	14.4
	100.0

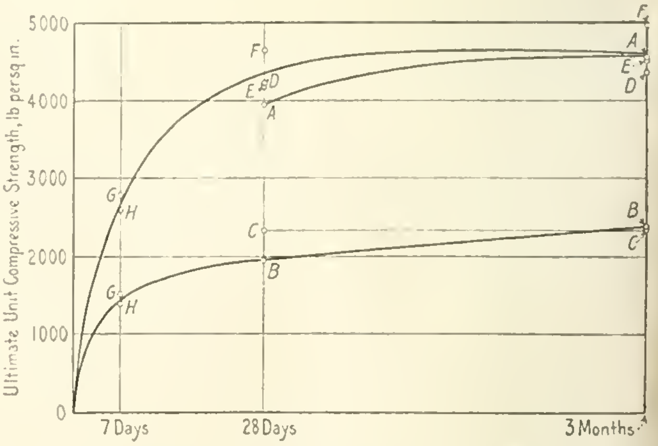


Fig. 1.—Compressive Strength of Specimens Prepared in June, 1918.

This mix corresponds very closely to the ordinary 1:2:4 mix; the resulting concrete contains about 6 sacks of cement per cubic yard of concrete.

The A specimens were prepared with water amounting to 6.7 per cent of the total weight of the other materials; they were of a very stiff consistency, were thoroughly tamped while being placed in the molds, and developed an average ultimate compressive strength of 3,915 lb. per square inch in 28 days and 4,559 lb. per square inch in 3 months.

All other specimens were prepared with water amounting to 10 per cent of the weight of the other materials or 69.4 per cent of the weight of the cement or about 104.5 per cent of the volume of the cement. The concrete for the specimens was of such a thin consistency that it flowed readily and was difficult to handle with shovels. It contained more water than need ever be used in practice to secure easy handling and a thorough filling of the forms.

Of these seven groups, the concrete for the B specimens was deposited in the molds and as it settled more was added so that the molds were well filled when the specimens were completed.

The specimens developed an average compressive strength of 1,962 lb. per square inch in 28 days and [illegible] lb. per square inch in 3 months.

The C specimens were tamped [illegible] with a wooden tamper. They developed an average compressive strength of 2,313 lb. per square inch in 28 days and [illegible] lb. per square inch in 3 months.

The D specimens were rodded every [illegible] minutes for 4 hours when the concrete had set so that the rod would not penetrate more than 2½ in.; these specimens developed

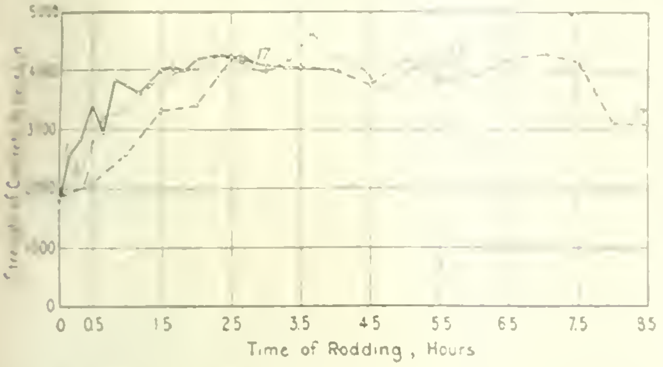


Fig. 2—Relation Between Strength of Concrete and Time of Rodding.

an average compressive strength of 4,211 lb. per square inch in 28 days and 4,363 lb. per square inch in 3 months.

The E specimens were rodded every 10 or 12 minutes for 2½ hours; they developed an average compressive strength of 4,188 lb. per square inch in 28 days and 4,512 lb. per square inch in 3 months.

The F specimens were rodded every 30 minutes for 7 hours; they developed an average compressive strength of 4,614 lb. per square inch in 28 days and 4,961 lb. per square inch in 3 months.

Of the G and H specimens, one-half were rodded every 30 minutes for 7½ hours and the other half were left untreated like the B specimens; the G specimens were stored under usual laboratory conditions and the H specimens were left in the molds and exposed to the weather to approximate field conditions.

The rodded G specimens developed an average compressive strength of 2,770 lb. per square inch in 7 days; the untreated G specimens a strength of 1,522 lb. per square inch in 7 days.

The rodded H specimens developed an average unit strength of 2,611 lb. per square inch in 7 days, the untreated H specimens a unit strength of 1,409 lb. per square inch in 7 days.

These results are shown graphically in Fig. 1.

A comparison of the A with the B specimens shows that the increase of water from 6.7 to 10 per cent decreased the strength of the concrete about 50 per cent.

A comparison of the C with the B specimens shows that the tamping did very little good.

A comparison of the D, E, and F with the A specimens shows that the wet concrete thoroughly rodded was a little stronger than the same concrete without excess water.

A comparison of the D, E, and F with the B specimens shows that, with this particular type of concrete the strength of wet concrete can be increased 100 per cent by rodding.

A comparison of the G and H specimens shows that the effect of rodding is about the same under regular working conditions as under laboratory conditions.

It is important to note that the D, F, G and H specimens were rodded until the concrete was so firm that it was not possible to rod them further; that is, they were rodded for a long period after initial set had taken place, with extremely beneficial results.

In this early work the rodding was not performed as systematically as in the later series of the tests.

A pointed ⅝-in. round rod was used for the rodding and the rod was pushed into the concrete about 15 times at each rodding but no attempt was made to push the rod into the concrete exactly the same number of times at each rodding.

Effect of Number Of and Interval Between Rodding.—In June 1919 a series of 54 specimens 6 by 12 in. were prepared to determine how the effect of rodding varies with the number of roddings and with the interval of time between successive roddings.

The composition by weight of the concrete for these specimens was:

	Per cent
Colorado River gravel P 1½ [illegible]	[illegible]
Colorado River gravel P ¾ [illegible]	[illegible]
Colorado River sand P ¼ in. R No. [illegible]	[illegible]
Colorado River sand P No. 14 R No. 48	[illegible]
Colorado River sand P No. 48	[illegible]
Cement	11.4
	100.0
Water	10.0

The series was divided into three groups of 18 specimens each. In each group, one specimen was not rodded at all; the remaining 17 were rodded from 1 to 17 times, respectively, the only difference between the three groups is in the interval of time between successive roddings which was, respectively, 10, 20, and 30 minutes for the three groups.

The results of the test of this series are shown in Fig. 2, which shows the compressive strength at 28 days. Each value shown in this diagram represents the strength of a single specimen. The diagram is not quite exact with reference to the time element because the first rodding was applied a little earlier than indicated by the figure. Each rodding consisted of pushing a pointed rod 20 times into the specimen.

The diagram shows that in each of the three groups, an increase in strength of more than 100 per cent was attained in about 2½ hours and that further rodding had no effect on the strength except in the case of the two specimens which were rodded when the concrete was more than 7½ hours old. In these cases the decrease in strength may have been partly due to the fact that the concrete was so stiff that when the rod was drawn out the cavity thereby produced did not close. In testing rodded specimens we found a number of cases in which the concrete had been rodded so long that the cavity produced by the rod remained in the concrete.

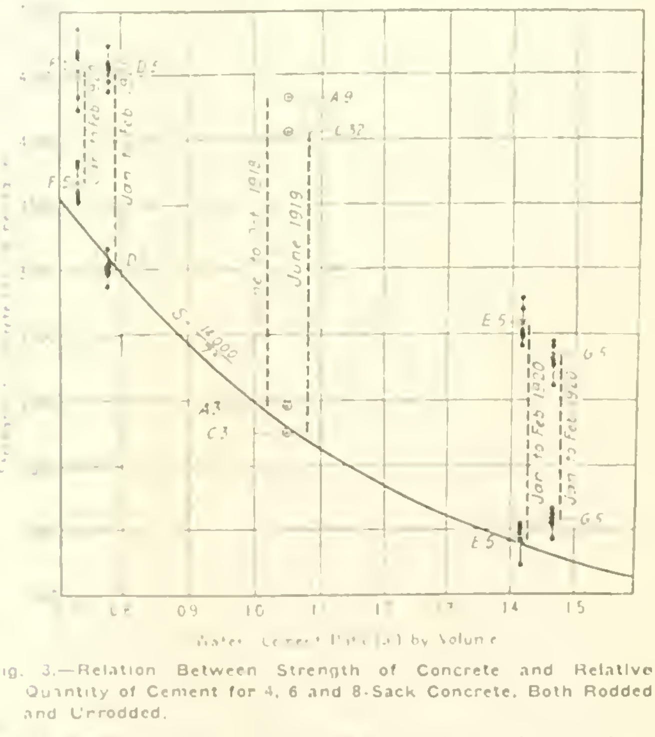


Fig. 3.—Relation Between Strength of Concrete and Relative Quantity of Cement for 4, 6 and 8-Sack Concrete, Both Rodded and Unrodded.

To determine whether the increase in strength of more than 100 per cent shown in Fig. 2 is due to a superior quality of the rodded concrete or to an inferior quality of the unrodded, it will be of interest to compare the strengths of the unrodded specimens with similar strengths secured in the investigations at Lewis Institute made for the Portland Cement Association.

The three unrodded specimens shown in Fig. 2 developed strengths of 1,670, 1,814 and 1,860 lb. per square inch, respectively, or an average strength of 1,781 lb. per square inch.

The average strength of 32 of the specimens shown in Fig. 2, all of which had been rodded from $1\frac{1}{2}$ to $7\frac{1}{2}$ hours, is 4,071 lb. per square inch The water-cement ratio was 1.65 and the expected strength, according to the Lewis Institute expression $S = \frac{14000}{7^x}$, is 1,814 lb per square inch; in this particular series, the strength of our unrodded specimens was about 2 per cent less, and that of our rodded specimens about 119 per cent more than that calculated by the Lewis Institute formula.

Relation Between Increase in Strength Due to Rodding and Relative Quantity of Cement.—In January, 1920, a series consisting of 40 6x12-in. specimens was prepared to determine how the increase in strength of concrete due to rodding varies with the relative quantity of cement in the concrete.

Of the 40 specimens, 20 were prepared so as to contain cement at 4 sacks per cubic yard of concrete and 20 at about 8 sacks per cubic yard:

TABLE I—GRANULOMETRIC COMPOSITION OF AGGREGATE IN 1920 SERIES

Group E. 4-Sack Concrete.	Pct.
P 1¼ in. R ¾ in	29.50
P ¾ in. R ¼ in	29.50
P ¼ in. R No. 12	15.95
P No. 12 R No. 22	3.50
P No. 22	8.95
Cement	9.60
	100.0
Water	9.00

Group F. 8-Sack Concrete.	Pct.
P 1¼ in. R ¾ in.	29.10
P ¾ in. R ¼ in.	28.91
P ¼ in. R No. 12	11.74
P No. 12 R No. 50	9.95
P No. 50	0.00
Cement	20.30
	100.0
Water	29.30

Group G. 4-Sack Concrete.	Pct.
P 1¼ in. R ¾ in.	29.75
P ¾ in. R ¼ in	29.50
P ¼ in R No. 12	12.00
P No. 12 R No. 50	11.25
P No. 50	8.22
Cement	9.28
	100.0
Water	9.00

Group D. 8-Sack Concrete.	Pct.
P 1¼ in. R ¾ in	29.50
P ¾ in. R ¼ in	29.50
P ¼ in. R No. 12	11.65
P No. 12 R No. 50	4.50
P No. 22	6.20
Cement	19.25
	100.0
Water	29.30

In each of the two groups, one-half the specimens were rodded seven times with half-hour intervals, each rodding consisting of pushing a pointed rod 10 times into the specimen; that is, half as often as in the series shown in Fig. 2, the remaining half were not rodded but the concrete was settled as well as possible by tapping the mold.

Sufficient mixing water was used to secure a flowing consistency in the concrete. All water which came to the surface during the rodding period was poured off.

The two groups were divided into two sub-groups by varying the granulometric composition of the aggregate as shown in Table 1, Colorado River gravel and sand being used in all cases.

The strengths of these specimens at 28 days are shown graphically in Fig. 3 plotted against the Lewis Institute water-cement ratio and in comparison with the Lewis Institute strength formula, $S = \frac{14000}{7^x}$, and also in comparison with the values shown in Figs. 1 and 2, which refer to specimens containing cement at a rate of about six sacks per yard

The rodded specimens shown in Fig 3 were not rodded according to any uniform method.

In the 1918 series, shown by A9, the specimens were rodded at intervals varying from 10 to 30 minutes until the concrete was so firm that further rodding was impracticable; each rodding consisted of pushing the rod into the concrete about 17 times.

In the 1919 series, for the 32 specimens represented by C23, each rodding consisted of pushing the rod 20 times into the concrete; the specimens received from 6 to 17 roddings, at intervals varying from 10 to 30 minutes.

In the 1920 series, shown by F5, D5, E5 and G5, each rodding consisted of pushing the rod 10 times into the concrete and each specimen received seven roddings at 30-minute intervals.

Fig 3 shows:

1 That the strength of good unrodded concrete is given quite accurately by the expression $S = \frac{14000}{7^x}$;

2 That rodded concrete is very much stronger than unrodded concrete.

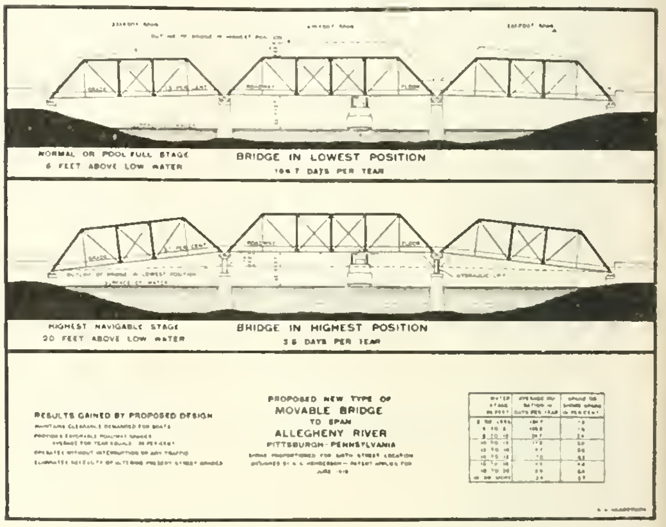
3 That the relative increase in strength due to rodding is greater for the lean mixes than for the rich;

4. That, for the particular concretes and types of rodding represented in Fig. 3, the increase in strength due to rodding is about 40 per cent for 8-sack, 100 per cent for 6-sack, and 140 per cent for 4-sack concrete.

An Unusual Scheme for a Liftable Bridge

Raising the Pittsburgh bridges which span the Allegheny River has been agitated since 1903. Numerous hearings and investigations have been conducted by the United States War Department. These have terminated in a final decree by the Secretary of War issued March 23, 1917; suspended March, 1918; and revived March 10, 1919, which declares the present bridges are obstructions and must be altered by revising spans and increasing the heights above water.

Persons unacquainted with Pittsburgh may not be aware of the fact that the territory immediately adjacent to the bridges sites is highly improved and that alterations to the street grades would result in damages rapidly mounting into millions of dollars. The streets on either side of the Allegheny River have been raised above flood level within recent years and all buildings, many of them very expensive, have been adjusted to the new grades. Owners of property in the vicinity of the bridges are bitterly opposed to any further disturbance of street grades and welcome any type of bridge construction which will cause no material change in the approach streets.



Proposed New Type of Movable Bridge to Span Allegheny River at Sixth Street, Pittsburgh.

The question will probably arise in the minds of many, why a movable bridge of the usual type has not been considered for these sites.

The Allegheny River discharges its water with a fairly swift current in the higher navigable stages. Should a bridge fail to open for the passage of a boat coming down-stream with a tow of barges the result would be disastrous. When it is considered that three bridges must open practically simultaneously the chances of failure to operate must be multiplied by three. This is naturally regarded as too great a hazard by the river traffic.

A recent traffic census of the down-town streets shows that the southern terminus of the 6th St. bridge in one of the most congested points in the city. To subject this heavy traffic to the delay caused by opening a movable bridge would create intolerable congestion. Consequently the ordinary type of movable structures has met with little favor from any source.

At the last hearing before the United States Engineers in 1915-16, city and county authorities were united in the opinion that grades on the bridges should not exceed 3 per cent and that it is to the best interests of the city to reconstruct streets and pay property damages at a cost aggregating $6,250,000 rather than erect a barrier to the development of the city by the creation of excessive grades on thoroughfares connecting the down-town areas.

A new type of bridge illustrated in the drawings has been proposed by Mr. A. A. Henderson, Assistant County Engineer, county of Allegheny, Pittsburgh, who has already applied for a patent on the idea. It will be noted that the drawings show but the general scheme, leaving the details to be worked out later when permission has been obtained to erect this type of bridge.

Three bridges, one each at [illegible] and [illegible]th St., spanning the river, are all affected by the order of the War Department and at each one the conditions are very similar.

The claim made for this new type of lift bridge is that it avails itself of the economies enjoyed by other movable bridges, and, in addition, eliminates the inconvenience arising from interruption to traffic either by land or water.

Another novel feature of the new bridge is the fact that all three spans would be manipulated, while other types of movable bridges operate by manipulating the central span only.

One of the first things that suggests itself in this mode of operation is the amount of separation that will occur in roadway floor at the ends of the elevated span when it is tilted to its highest position. This amounts to 6 in. for a bridge of the spans and lift shown in the sketch. By raising and lowering the end pin at pier in a vertical plane and providing for a resultant horizontal motion of end pin at abutment, the separation on roadway can be equally divided between the two ends of truss—3 in. at either end.

The saving of the immense sum required to pay property damages which would be necessary if an ordinary type of high level bridge were built is perhaps the most important saving and advantage.

Why Men Strive to Get Ahead

By P. B. McDONALD,

Assistant Professor of English, College of Engineering, New York University.

The "Gloomy Dean" Inge of St. Paul's cathedral, London, said recently in one of his characteristic addresses that man is naturally so indolent he will toil only to obtain food and shelter. He was arguing against industrialism and for a return to rural life, and was trying to show that the only occupations satisfying to man through inherited instincts are farming and hunting.

Why is it then, when he has attained food and shelter, that man continues to strive as desperately as before? Why is it, after we reached the civilization of our grandfathers, we continued to pile up luxuries and garnishings? Why cannot we live as Thoreau did at Walden Pond, spending nine cents a day and working six weeks in the year? Thoreau considered that he was happier in this rustic cabin, with leisure to ponder over nature, than the city-dweller who works the year round and sees nature only during two weeks of vacation.

Herbert Spencer, reflecting on philosophy in his individualistic way, remarked that man strives for position, and the satisfaction of feeling above others. Said this "synthetic philosopher": "It is incredible that men should make the sacrifices, mental and bodily, which they do, merely to get the material benefits which money purchases. . . What merchant would spend an additional hour at his office daily, merely that he might move into a larger house in a better quarter? In so far as health and comfort are concerned, he knows he will be a loser by the exchange; and would never be induced to make it, were it not for the increased social consideration which the new house will bring him. Where is the man who would lie awake at nights devising means of increasing his income in the hope of being able to provide his wife with a carriage, (a motor-car would be a more appropriate example to-day) were the use of the carriage the sole consideration? It is because of the eclat which the carriage will give, that he enters on these additional anxieties. . . . . . To be distinguished from the common herd—to be somebody—to make a name, a position—this is the universal ambition. . . . We do not mean to say that men act on the consciously reasoned-out conclusions thus indicated; but we mean that the conclusions are the unconsciously-formed products of their daily experience." According to Spencer, then, men struggle to gain deference and respect rather than the direct use of luxuries. Such a condition opposes the theories of the socialists, who would have us all enjoying an equal share of the good things of life.

One of the best analyses of the motives actuating gregarious man is contained in Carlyle's extraordinary book "Sartor Resartus." The Scottish author has an eccentric German professor, Teufelsdröckh, [illegible] the [illegible] of his fellow townsmen as he looks upon them from his attic window. Says the professor: "Upward of five hundred thousand two-legged animals without feathers lie around us, in horizontal positions, their heads in nightcaps, and full of the foolishest dreams. . . . . All these heaped and huddled together, with nothing but a little carpentry and masonry between them, crammed in like salted fish in their barrel, or weltering, shall I say, like an Egyptian pitcher of tamed Vipers, each struggling to get its head above the others."

Such was this cranky Scot's idea of modern civilization, "a pitcher of tamed vipers each trying to get its head above the others." Yet Carlyle toiled more than most men to get his head above the crowd, and no one emphasized more than he the world's need for leaders with their head above the mass. Carlyle would say that for all men to have their heads on the same level brings that peril of democracy—shortsighted mediocrity, lacking inspiration and ideals. Spencer would say that to remove the possibility of the hard working or exceptionally-gifted man getting his head above others destroys the incentive for work except of a mechanical and indifferent kind. Proper respect and encouragement should be given deserving individuals, lest they cease to strive. This applies to the underpaid engineer.

Individuals as a philosophy has been criticised so severely since standardization and organization became popular that its true meaning should be explained. It means not oddity and self importance, nor refusal to co-operate merely for the sake of being different, but it means the self-development of individuals able to think for themselves and requiring little regulation and interference to keep in order. Spencer pointed out that placing men under restraints and mechanical patterns develops mollycoddles. He meant, of course, mental mollycoddles,—individuals of poor judgment and flabby initiative. Another effect has been the wide discontent which followed recent efforts to standardize human nature. To allay this unrest, the men in power in industry increased wages and added luxuries to the factories' welfare department, only to find that these sops brought but temporary benefit.

Charles S. Myers in a recent paper before the British Ceramic Society recommended "psychological management" rather than "scientific management," as a better method of suiting each worker to his job and keeping him satisfied, since scientific management tends to treat men as cogs in a machine, while psychological management recognizes individual talents and eccentricities. Likewise, an editorial in the British magazine "Engineering," arguing for individualism, said: "The creative mind, in short, to which every great increment of wealth can be traced, fits in badly with a communistic or a co-operative scheme of society. The man of genius is ever and necessarily an individualist."

The point of all these arguments is that man will always strive to get ahead, no matter what socialistic or co-operative rules are laid upon him, and that this innate wish to rise above the herd is desirable, and beneficial to society. The government which recognizes most clearly that exceptional individuals must be rewarded suitably, and shown due respect, will develop the greatest leaders, not only in politics and statesmanship but in science and invention. The industrial corporation which rewards most appropriately workers of unusual ability will attract such men, and the reward of higher wages or welfare conveniences is by no means the chief incentive that keep men satisfied. Working under an inspiring leader, being encouraged to express ideas about the work, and being treated in a sincere and honest manner, are considerations that move employees as much as anything else. But these advantages should not be flaunted in a way that antagonizes by its very obviousness. Appealing to the individual, especially to the unusual individual, means leaving something to his imagination, he does not like to be hustled into admiration of the company, any more than he likes to be catalogued as a cog in a machine. After all men are human beings, though they submit to temporary expediency which makes them appear otherwise.

7,720,000 Tons of Shipping Under Construction.—A statement issued a few days ago by Lloyd's Register of Shipping shows an aggregate of 7,720,000 tons of shipping under construction on July 1, in all countries. Of the total 3,578,000 tons was in the United Kingdom and 2,105,000 in the United States. Holland was third with a total of about 100,000 tons.

Rapid Determination of True Net Sections of Riveted Tension Members

By C. R. YOUNG,

Associate Professor of Structural Engineering
University of Toronto

Before the capacity of a riveted tension member can be calculated, it is necessary to determine the true net section. If there be but one line of rivets in the member, the net section is, of course, the gross section less one rivet hole, the hole being assumed in accordance with the usual custom as ⅛ in. larger than the diameter of the rivet before driving. When, however, there are two or more lines of rivets, the true deduction is not so easily found.

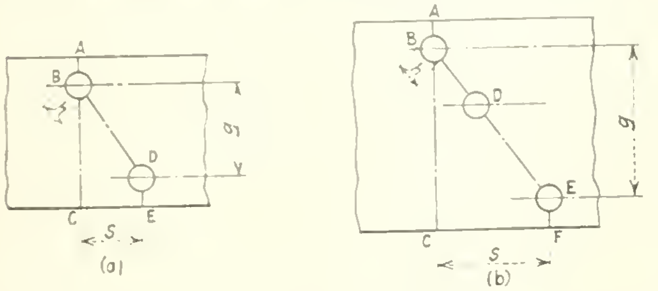


Fig. 1.

A common method of providing for this reduced area, and one that is given with certain accompanying tables in a number of handbooks, is to deduct a second hole in full if the zig-zag net section through this second hole and through the first one is less than the net right section through the first hole. Thus, referring to Fig. 1(a), if s is less than $(2gh + h^2)^{1/2}$, two full holes must be deducted, whereas if s is greater than $(2gh + h^2)^{1/2}$, only one hole is to be deducted. Similarly, for the case shown in Fig. 1(b), 3 full holes are to be deducted if s is less than $(2gh + h^2)^{1/2}$.

The fallacy of requiring a full hole to be taken out if the stagger is but slightly under the critical one for maintaining equal sections is evident. There is another reason, however, why the method of merely comparing right and ziz-zag sections on the basis of net areas is incorrect. There is a component of shearing stress on the diagonal section that should be combined with the normal stress on the section. The resultant stress is, therefore, larger than on a right section of the same area.

Several writers have already pointed out the theoretically correct method of computing deductions and its agreement with actual experiment. Victor H. Cochrane in Engineering News for April 23, 1908, indicated the method; T. A. Smith, in Engineering News, May 6, 1915, submitted a diagram based on true maximum stresses from which the number of holes to be deducted for ⅞-in. rivets could be determined; and D. B. Steinman in Engineering News-Record, June 4, 1917, proposed two alternative approximate rules for calculating the correct deductions.

On the basis of the theory that the maximum stress on any element of the cross-section arising from the combination of normal and shearing stresses should not exceed the safe stress for the material employed, the number of rivet holes to be deducted from the gross right sectional area of a tension member (Fig. 1) to give true effective section would be given by the following formula:

$$n = 1 + x_1 + x_2 + x_3 + \ldots \qquad (1)$$

$$\text{where } x = \frac{g}{h} - \frac{2(g^2 + s^2 - h\sqrt{g^2 + s^2})}{h(g + \sqrt{g^2 + 4s^2})}$$

g = distance between gage lines;

h = diameter of rivet hole (dia. of rivet + ⅛ in.);

s = stagger of rivets with respect to previous rivet.

Formula (1) is to be applied to alternative sections, the successive terms representing the deductions for successive holes considered in a chain across the member. The particular group of rivets to be considered is that which will give the greatest total deduction, whether the rivets lie in adjacent gage lines or not.

To obviate the large amount of work required in solving formula (1) for each case, the diagrams given in Figs. 2, 3 and 4 have been prepared. It is believed that these are simpler of application than the diagram prepared by T. A. Smith, to which reference has been made above. The curves give the exact deductions for the three commonest sizes of rivets in structural work, viz., ⅝, ¾, and ⅞-in.

The saving in time effected through the use of diagrams for true effective section will be evident by a study of Fig. 5. The weakest section in this case can be precisely determined only by comparing the deductions on sections A B C D, A B F C D, A B F C I J, A B F G, A B F I J, E F C D, E F G, and E F I J. Of course, it is usually possible to eliminate some of the zig-zag sections by inspection. In the present case, for example, it is evident that the deductions along sections A B F G, E F G, and E F I J are less than along A B C D. These sections, therefore, need not be considered in making the comparison.

To take a numerical case, assume the following values for the indicated dimensions of Fig. 5:

$g_1 = 2\frac{1}{2}$ in. $s_2 = 2$ in.
$g_2 = 5$ in. $s_2 = 1\frac{1}{2}$ in.
$g = 2\frac{1}{2}$ in. $h = 1\ (= \frac{7}{8} + \frac{1}{8})$ in.

Then, applying formula (1) to the sections that cannot be

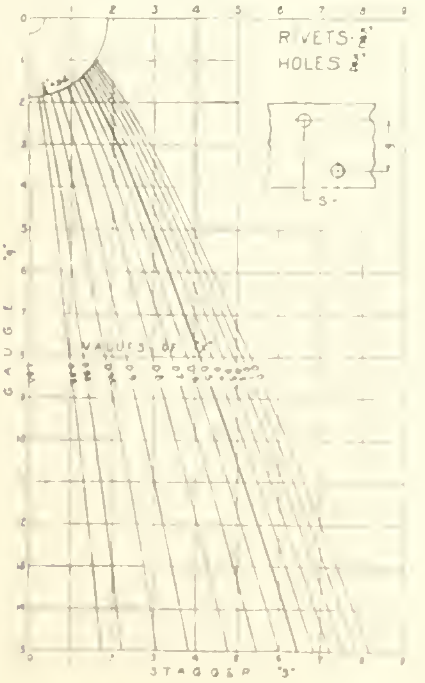


Fig. 2.

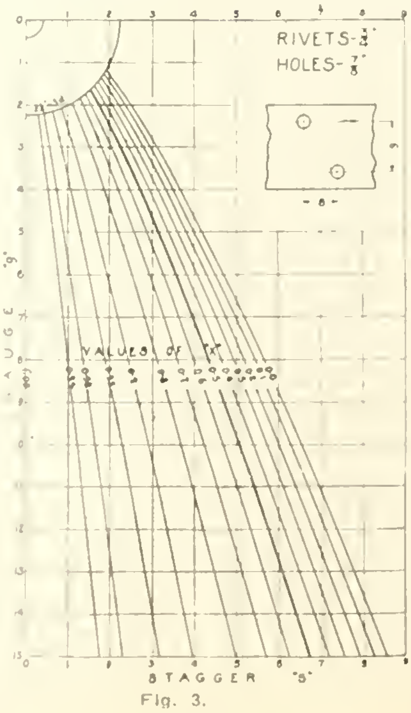


Fig. 3.

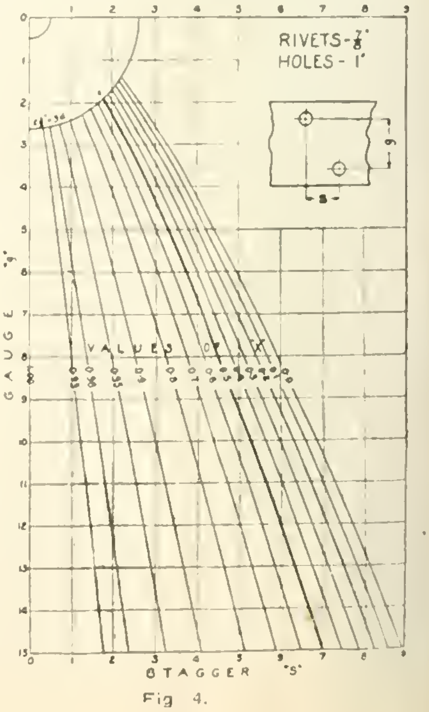


Fig 4.

eliminated by inspection we [illegible] in the various cases to be as follows:

A B C D = 1 − 1 = 2[illegible]
A B F C D = 1 − 0.55 [illegible]
A B F C I J = 1 − 0.55 − [illegible] 2.10 holes
A B F I J = 1 − 0.55 [illegible] holes
E F C D = 1 − 0.85 = 1[illegible]
E F I J = 1 − 0.96 = 1[illegible]

Thus, the most dangerous section [illegible] A B F I J, for which 2.51 holes should be de[illegible]

It is to be remembered that th[illegible] of which these diagrams is based is so fashioned [illegible] deduction is to be made from the gross right section [illegible] member. If an 8x½-in. plate contained two 1-in. [illegible] gage and 2-in. stagger, the net effective area [illegible] considered in design would be (8x½) — (1.85x0.[illegible]) [illegible]

In design, it is often desirable to [illegible] the necessary stagger in order that the true deduc[illegible] exactly one hole, or two holes. Thus, for the [illegible] in Fig. 1(a), assuming ¾-in. rivets, the stagger [illegible] to make n = 1 is found by noting on Fig. 3 the hor[illegible] scale reading of the point where the proper gage line [illegible] the curve

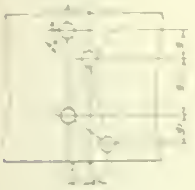


Fig. 5.

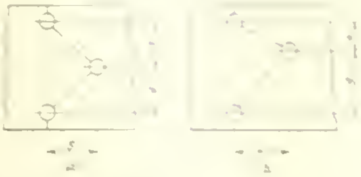


Fig. 6

x = [illegible]. For the case shown in Fig. 6(a), the value of s required to make n = 2, is found, if the rivet be ¾ in., as before, by reading from Fig. 3 the stagger corresponding to the point where the gage line intersects the curve x = 0.5. Where the situation is as illustrated in Fig. 6(b), the stagger necessary to make the total deduction equal to exactly 2 holes is found by noting on the horizontal scale the reading for the point where a vertical intercept between the gage lines representing g_1 and g_2 is bisected by the curve x = 0.50.

In order to apply the methods described to the calculation of net sections in angles, it is only necessary to consider the angle developed. If there is one line of rivets in each leg, both the gages are g_1 and the thickness of the angles is t, then the angle would be equivalent to the plate shown in Fig. 1(a), g being equal to $2g_1 — t$.

Average Weights of Long Leaf Southern Pine Lumber

The following average weights of southern pine (long leaf) when worked to standard size and based upon test weights taken during 1915 on larger quantities of each item listed, of the long leaf pine lumber manufactured by members of the Southern Pine Association.

DRY.	
*Flooring, 13/16x2¼	2,000
*Flooring, 13/16x3¼	2,200
*Flooring, 13/16x5¼	2,400
*Ceiling, [illegible]	1,000
*Ceiling, ½	1,2[illegible]
*Ceiling, ⅝	1,500
*Ceiling, ¾	1,800
Partition, [illegible]	1,900
Shiplap and D. & M. [illegible]	2,400
Grooved roofing, 13/16	2,600
Com. boards and fencing, 1x4, 6, 8 or 10-in., S 1 S or 2 S to 13/16	2,700
Com. boards 1x12, S 1 S or 2 S to 13/16	2,800
Com. boards and fencing, 1x4, 6, 8 or 10-in., rough	2,400
Siding, from inch stock	1,100
Siding, from 1¼-in. stock	1,400
Drop siding to ¾	1,900
Moulded casing, 4½ to 5¼	2,000
Moulded base from 8, 10, 12-in. [illegible]	[illegible]
Finish, in[illegible] S 1 S or S 2 S t[illegible]	[illegible]
Finish 1¼, 1½ and 2-in., S 1 S or S 2 S [illegible] and th[illegible]	[illegible]
Finish, 1, 1¼, 1½ and [illegible]	[illegible]
Com. boards 1x[illegible]	[illegible]
2x4, 2x[illegible] S 1 S [illegible] 1 E [illegible]	[illegible]
2x4, 2x6 and [illegible]	[illegible]
2x10 [illegible] S [illegible] S 1 E to [illegible]	[illegible]
2x10 and 2x12 [illegible]	[illegible]
[illegible]N	
2x14 [illegible] S 1 S 1 E	[illegible]
2x14 [illegible] x12 [illegible]	[illegible]
4x4 [illegible] S [illegible] S 1 [illegible]	[illegible]
4x4 [illegible]	[illegible]
6x[illegible]	[illegible]
6x8 [illegible] S 4 S	[illegible]
Plast[illegible] dr[illegible]	[illegible]
Bark[illegible]	[illegible]

*For hollow back flooring, ceiling and d[illegible]

What the Structural Engineers' Association of Illinois Has Accomplished

The Structural Engineers' Association of Illinois, organized in 1915, now comprises in its membership [illegible] of all licensed structural engineers of the State. Some of the things accomplished by the Association were outlined by its president, Joachim G. Giaver, in an address presented at the last annual meeting. We quote as follows:

The organization of the Structural Engineers' Association of Illinois was accomplished very soon after our license law was first passed in 1915. The sole purpose of the Association was to protect the rights granted to structural engineers of the state under the law, and to secure such additional rights and privileges as could be had by later revisions of the law, as well as further in a business way the true interest of the licensed structural engineer in this state, and work to a better understanding by the public of an engineer's activities and the importance of the work of an engineer from the standpoint of public safety.

This association is responsible for and must be given credit for "the miracle in engineering practice" now taking place in the practice of structural engineering in this state. Our first license act secured in 1915 was limited in its scope but broad enough to give the structural engineer licensed under this act a chance to grasp opportunities and secure and develop business for himself which was not possible before. It is my pleasure and privilege to advise you that solely through the efforts of this association we have secured the passage of a revision of the original license law passed in 1915 which new law is known as "The Illinois Structural Engineering Act." This law was duly approved by Gov. Lowden last June, and it first of all gives to the structural engineer licensed to practice under the same all the rights and privileges that the association asked, and in the opinion of at least six of the best constitutional lawyers of the state, the law is constitutional and fool-proof.

Since the enactment of this law the building permits of Chicago will show that the structural engineers have commenced to grasp the opportunities granted to them by this law. This new condition has opened an unlimited field for independent engineering practice and activity in the building construction field. Through the efforts of this association the Chicago Building Department now recognizes the seal of a licensed structural engineer as the equal of an architect's seal and gives the structural engineer all the rights and privileges granted to the other profession no matter what the character of the buildings may be.

Another factor to aid and assist the structural engineer was the securing in the last legislature of an amendment to the General Lien Law by and through the efforts of this association, extending full lien rights to structural engineers. This should mean the saving of thousands of dollars annually to our members. Another saving to our members was the securing by this association of a reduction in the annual renewal fee demanded by the state for renewal of licenses. This renewal fee under the new law is $1 instead of $10 under the old law. The penalty under the old law for allowing a license to lapse on account of non-payment of the renewal fee was figured at the rate of $15 per year, during the period of such lapse, while under the new act we were able to have this changed and reduced to a lump sum of $5 for a period of not to exceed five years. This is a substantial saving in many cases where a licensed engineer may leave the state or retire from the active practice of his profession for a period of not to exceed five years. Our new act provides that the practice of structural engineering by one not duly licensed, a fine and penalty under which each day of such practice constitutes a separate offense, making the penalty cumulative, which makes the penalty so large that it would not pay an unscrupulous outsider or unlicensed engineer to attempt such practice, while our first law only provided for a small fine which could be paid without hardship on an ordinary job. This clause in the new law is a great protection to the licensed structural engineer.

I could go on enumerating many other good points the association has accomplished for the licensed engineer of this state. Suffice to say that this association, through its directors, advisory board and officers is watching and safeguarding in all possible ways the interests of its members, and is doing everything in its power to promote the standing and reputation of the association and the profession. Our efforts have succeeded in creating a harmonious co-operation between our association, the architects' association, the Western Society and the local chapter of the American Institute of Architects, which has resulted in the appointment of a combined committee called the Joint Professional Committee on Materials and Methods, the purpose of which is to study conditions and adopt uniform methods in connection with construction, specifications, accounting, use of materials, and to suggest changes in the building code for the benefit of building construction.

A proposition has been made for a new structural steel ordinance and structural timber ordinance. In the structural steel ordinance is included specifications for the use of nickel steel. Chicago is probably the first city in the United States where an ordinance has been proposed for the use of nickel steel in building construction. It is my idea that our association besides being a business association to promote the interest of the licensed structural engineer and to protect their license law, should, in a broad way, interest itself especially in public questions dealing with engineering problems. The association should promote activities in the direction of standardizing engineering practices, engineering charges, engineering etiquette, and other questions of similar nature of interest to the engineering profession.

Determinations of Stress-Deformation Relations for Concretes Under Repeated and Continuous Loadings*

By G. M. WILLIAMS.

The deformation of concrete under stress, while of great importance in the design of reinforced concrete structures, is not generally given much consideration in tests of concrete. Although a definite value for the modulum of elasticity may be used in design, it is generally considered that the stress-deformation relation is not linear, even for small loads, and as a result such a value as is used is only an approximation which practice has shown to give safe results. Some authorities hold that the relation becomes linear for repeated applications of load, while others have found the linear relation only in concrete which has aged for a long period of time.

To find what the stress-deformation relation really is for various concretes made with our regular run of materials for different conditions, such as wet and dry, and for repeated and continuous applications of load, the work described later was undertaken.

Preparation of Concrete. Unless stated otherwise, all determinations of the stress-deformation relations were made on concrete test cylinders 8 in. in diameter by 16 in. long stored in wet sand until the day of test. In all cases 6 by 12-in. specimens were prepared for test at 28 days, at which time the stress-deformation observations were started. The materials used were a standard portland cement, Potomac River sand and gravel, and blast furnace slag. Just previous to testing, the specimens were removed from sand storage and the ends made plane and parallel by grinding on a steel plate with water and carborundum. All tests were made in a 200,000-lb capacity testing machine having a spherical bearing block attached to the moving head, with the ends of the concrete specimen in direct contact with the metal head and weighing platform of the machine.

Measurement of Deformation.—An instrument consisting of two independent yokes, each having three points of contact with the surface of the test specimen, fitted with three Ames diel gages graduated to read to 0.0001 in., was used to measure the deformation under load.

The yokes are spaced 10 in. apart so that the average deformation per inch can be determined to 0.000001 in. This instrument was designed by Mr H. A. Davis, formerly with the Bureau of Standards. While this type of instrument requires a greater number of observations and considerably more computation than does the averaging type fitted with a single dial, our experience would indicate that the former is generally more satisfactory and reliable since unequal deformations due to non-uniform loading is made apparent by unequal rate of movement of the dial hands. With the three-dial instrument, readjustment of position can immediately be made, while with the single-dial type such unequal loadings cannot be detected.

Stress-Deformation Curves.—While it is true in a few cases that the first applications of load to a specimen will result in a curve which may be expressed by an exponential equation, this relation does not hold in any case for the concretes included in these tests for further application of load. Except in a few cases for 1:3:6 concretes at 28 days and wet-consistency 1:2:4 concrete at the same age, a straight line relation was obtained for the first application of load. In general the deformation for a unit stress of 200 lb. per square inch is less tban that obtained for further equal increments of stress so that a straight line drawn through the values for the higher loads will fall sligbtly to the left of the origin.

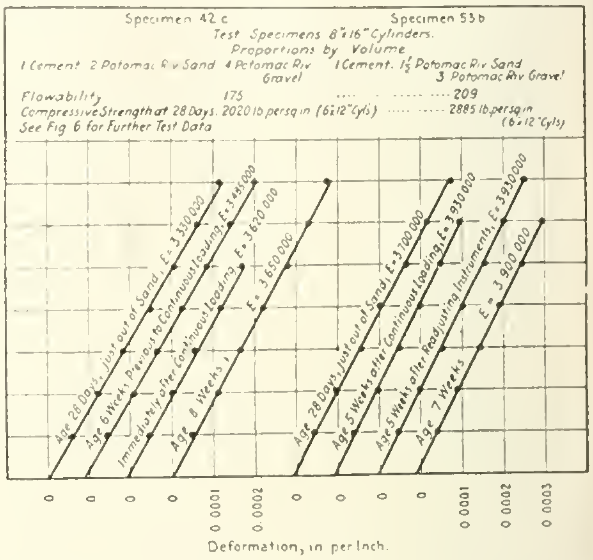


Fig. 1—Modulus of Elasticity of Concrete in Dry and Wet Conditions for Loads in Excess of Usual Working Loads.

Modulus of Elasticity, E, of Concrete for Wet and Dry Condition.—In Fig. 1 are shown representative stress-strain relations for concrete in the wet and dry condition. Specimen 22b at the age of 28 days, when removed from wet sand storage, had a modulus of elasticity, E, of 3,800,000 lb. per square inch; one week later after drying in air the value for E was 4,040,000. At the age of 8 weeks, after 10 days' immersion in water, during which time the specimen absorbed 4.4 per cent by weight, the value for E was 3,950,000. After further drying in air for 2 weeks the value obtained was 3,985,000. For specimen 29a, in which slag was used as a coarse aggregate, the value after removal from damp sand was 4,610,000 lb. per square inch; after 10 days in water, 4,700,000; and after drying for 1 week in air, 4,320,000 lb. per square inch. The range of values in both cases are no greater than would be expected for repeated removal and replacement of instruments for a specimen stored under uniform and constant conditions of humanity. Further data showing similar constant values for the wet and dry condition are contained in Figs. 2 and 3.

Deformation of Concrete Under Repeated Loads.—In Fig. 2 are shown the results of repeated applications of load on a specimen of 1:2:4 concrete which had a strength of 1,565 lb. per square inch at 28 days as determined by tests of 6 by 12-in. cylinders. All load was removed in every case after the maximum of 1,000 lb. per square inch was applied. The lines for "zero load" and "1,000-lb.-per-sq.-in load" may be considered at the elevation of the upper surface of the cylinder during the progress of the test. Load was first applied immediately after removal from wet sand with the result as shown in the stress-deformation curve marked 1 at the right of the diagram. Load was released and a permanent set of about 0.000033 in. per inch was noted. Further applications of load equal to two-thirds of the ultimate strength of the specimen showed [illegible] increase in set beyond that resulting from the [illegible] Standing over night with no load, temperature [illegible] gave readings the next morning which seemed [illegible] nearly as great a permanent set as resulted from [illegible] of loads the day previous. The modulus [illegible] for loading No. 10 is slightly higher than for loading [illegible] day. The turning off of the heat in the [illegible] the second day is shown by the last load applied late in the evening of that day. On the third day there was no heat, but the repeated application of loads, together with the direct rays of the sun later in the day, gradually increased the permanent set and caused corresponding increases in the deformation for maximum load. Late on the fourth day the permanent set for zero load was approximately the same as for the second day.

---

*Abstract of a paper presented at the 23rd annual meeting of the American Society for Testing Materials, Asbury Park, N. J., June 22-25.

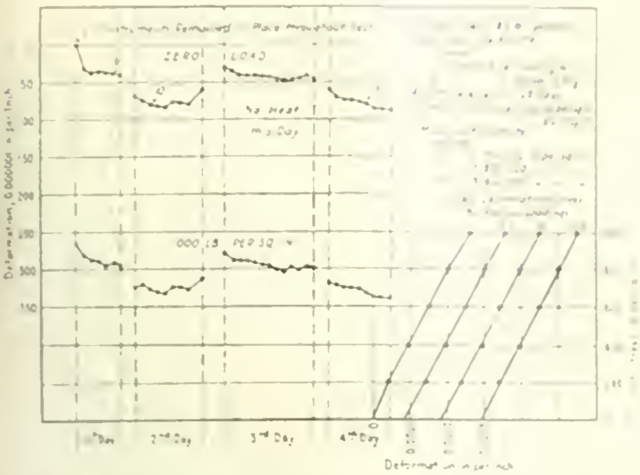


Fig. 2—Deformation of Concrete Under Repeated Applications of Loads in Excess of Usual Working Loads.

Continued repetitions of load tend to raise slightly the value of the modulus of elasticity. In the case of specimen 42b, the value for E gradually increased during the test, becoming 3,950,000 lb. per square inch for the 35th loading on the fourth day. It should be noted that these loadings are well beyond the strengths ordinarily assumed in design for concrete of this quality.

Deformation of Concrete Under Continuous Load.—The deformation of concrete under repeated loads and continuous loads is illustrated in Figs. 3 and 4. Specimen 42c, made of 1:2:4 concrete having a compressive strength of 2,020 lb. per square inch at 28 days, was placed in the machine immediately after removal from wet sand, and the value for the modulus of elasticity was found to be [illegible]30,000 lb. per square inch. After drying in the air for 2 weeks, the value was determined as 3,485,000. After a number of loadings up to 1,400 lb. per square inch [illegible] the [illegible] was [illegible] a load [illegible] lb. per square inch was maintained for [illegible]. The [illegible] permanent set of the concrete [illegible] of temperature changes is indicated by the dotted line [illegible] the center of Fig. 4. The effect of temperature changes due to the turning off of the steam heat each afternoon is indicated by the rise of the curve at the end of each day. This was especially marked for the fifth day when the night was unusually cold. Each morning the beam was found dropped and a load equivalent to from 10 to [illegible] lb. per square inch was usually required to balance it. During the day the higher temperature in the room in several cases caused the beam to rise so that the actual load would be approximately [illegible] lb. per square inch more than had been applied originally through the machine. On the seventh day all load was released and repeated and loadings of 1,400 lb. per square inch were applied. As shown in Fig. 3 the modulus increased slightly to 3,520,000. After storage in air for one week further loadings to 1,400 lb. per square inch gave a value of [illegible].

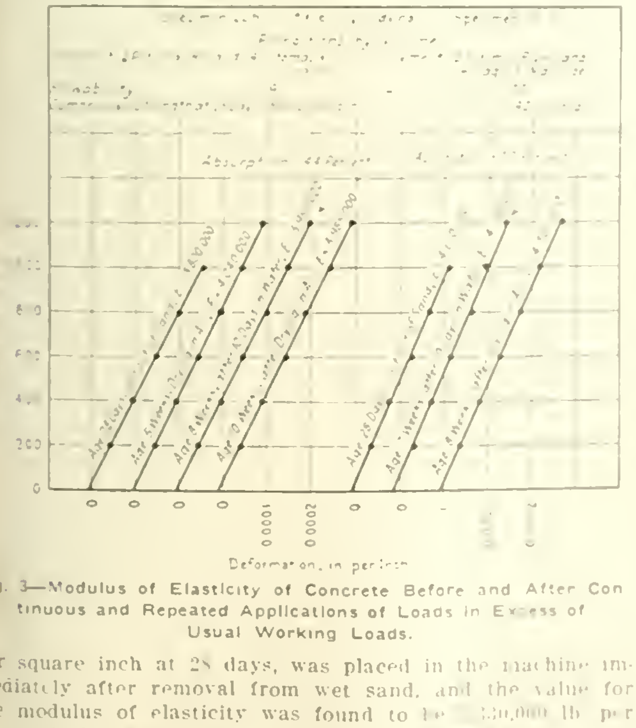


Fig. 3—Modulus of Elasticity of Concrete Before and After Continuous and Repeated Applications of Loads in Excess of Usual Working Loads.

As shown in Fig. 3 similar results were found for specimen [illegible]b, a 1:1½:3 proportion concrete which had a strength of 2,88[illegible] lb. per square inch in 28 days. In this case a constant load of 1,000 lb. per square inch was applied for a period of six days with detailed results quite similar to those shown in Fig. 4 for the 1:2:4 proportion concrete.

Modulus of Elasticity for Proportions Ranging from Neat Cement to 1:3:6 Concretes for the Extreme Ranges of Consistencies Commonly Used in Practice. The data shown in the preceding groups were obtained from tests of various concretes prepared over a period of time in the concrete laboratory of the Bureau of Standards and while giving definite information as to the properties studied are of little value in indicating the extreme range of values which will result from wide variations in cement content and in consistencies for the cement and aggregate. It is clear from a study of test data that the only function and value of aggregate in a concrete, so far as compressive strength is concerned, is to furnish an economical mixture as compared with the cost of neat cement, and that some strength under such conditions results, not because of the presence of the aggregate, but in spite of its presence in the mix. In other words, cement is the one strength-giving element in the mix and aggregate is used only for the sake of economy.

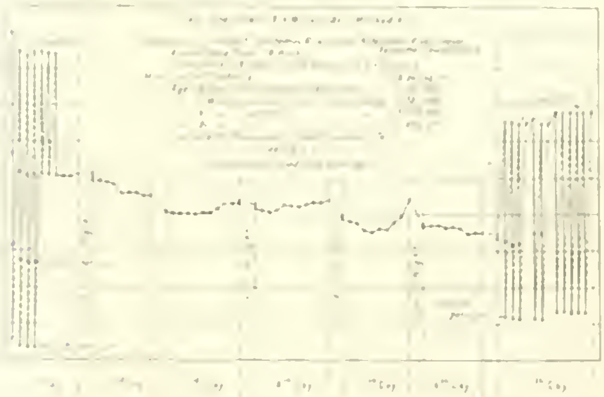


Fig. 4—Deformation of Concrete Under Repeated and Continuous Application of Loads in Excess of Usual Working Loads.

With this point of view, concretes were prepared ranging in cement content from neat cement to 1:3:6, having two consistencies or flowabilities.

These concretes were composed of a normal portland cement, Potomac River sand passing the ¼ in. screen, and Potomac River gravel the ¾ in. screen. Sand and gravel were proportioned by volume in a cubic foot measure, the materials being taken from stock piles which had just previously been wet by rains. Cement was weighed to insure the same quantity for each batch. Mixing was continued for two minutes in a batch mixer for the concretes and four minutes for the neat cement pastes. The above procedure was followed to duplicate in every way possible the best control which might be employed in the field when using the same materials.

Consistency was controlled and measured by means of the "flow table" which has been employed for this purpose in the concrete laboratory of the Bureau of Standards since the early part of 1919. Flowability is measured by the increase in diameter of a mass of concrete molded in the shape of a frustum of a cone on a table top which may be raised and dropped through a fixed distance by means of a cam. A mass of concrete 6 in. high having upper and lower diameters of 8 and 12 in., respectively, is molded on metal covered top, the form withdrawn and the table top raised and dropped 15 times through a distance of ½ in. The mass usually spreads concentrically; and two diameters at right angles, the long and short ones if difference is apparent, are measured by means of a proportional caliper which is graduated in such a manner that the sum of the two readings gives what is called "relative flowability." This figure is always greater than 100 and is obtained by dividing the new diameter of the mass by the old and multiplying by 100. Tests have shown that flowability is directly proportional to the percentage of mixing water by weight of dry materials in any mass; also that flowability as measured by the "flow table" varies directly with the velocity of flow in a steel chute for all usable and workable concretes.

In these tests the total amount of water used was determined as carefully as possible by drying representative samples of the wet sand and gravel, but as is true in practice, the actual amount used is of no consequence, since a definite flowability was desired and as much water was added as would result in the required consistency.

The two flowabilities used, 165 and 240, represent the extremes which would ordinarily be used in practice in structural work. A flowability of 165 is too low to permit placing through ordinary chute systems, while a flowability of 240 is as great as is generally needed in practice. The addition of more mixing water would result in considerable segregation for this particular combination of fine and coarse aggregates.

For modulus of elasticity determinations, two 8 by 16-in. cylinders were prepared from each batch and three 6 by 12-in. cylinders were molded for test at 28 days. All specimens were stored in wet sand for 27 days, after which they were removed. These data are shown in tabular form in Table I.

As would be expected, compressive strengths and values of the modulus of elasticity are lower for the flowability of 240 than for that of 165, except for the dry neat cement mix. The only explanation which can be offered for this discrepancy is the possibility that insufficient work was done on the mass to result in the plastic condition which is attained in laboratory tests of neat cement only after a minute or more of vigorous working of a small lot of material. A flowability of 165 for this material did not result in a plastic mass but a large ball was formed, which rolled around without the distortion of the mass which is necessary to obtain the required plasticity. The higher flowability of 240 resulted in a mass which readily flowed in the mixer.

TABLE I. MODULUS OF ELASTICITY AND COMPRESSIVE STRENGTH OF CONCRETES OF DIFFERENT PROPORTIONS AND TWO FLOWABILITIES.
Potomac River Materials—Sand 0 to ¼ in., Gravel ¼ to ¾ in. Stored in Wet Sand for 27 Days.

Relative flowability.	Proportions by volume.	Modulus of elasticity, 8 by 16-in. cylinders, lb. per sq. in. Individual.	Average.	Compressive strength, lb. per sq. in. at 28 days. Ave. of three 6x12-in. cylinders.	Ratio modulus of elasticity to compressive strength.
	Neat cement	3,640,000 3,750,000	3,695,000	7,860	470
	1:1:2	3,685,000 3,780,000	3,732,500	3,220	1,160
165*	1:1½:3	3,485,000 3,410,000	3,447,500	2,805	1,230
	1:2:4	3,010,000 3,075,000	3,042,500	2,010	1,515
	1:3:6	2,490,000 2,620,000	2,555,000	1,080	2,370
	Neat cement	3,540,000 3,570,000	3,555,000	9,285	386
	1:1:2	3,460,000 3,210,000	3,335,000	3,070	1,085
240*	1:1½:3	3,200,000 3,150,000	3,175,000	2,425	1,310
	1:2:4	2,850,000 2,870,000	2,860,000	1,850	1,545
	1:3:6	[illegible] [illegible]	1,832,500	800	2,290

*Relative flowability of 165 is about the driest which can be used in reinforced concrete work. A relative flowability of 240 is as fluid a mix as need be used. For this particular combination of aggregates the addition of much more water would have caused excessive segregation especially for the leaner proportions.

Summary.—The data of which the preceding may be considered representative bears out the results of tests previously made in our laboratory that:

The true stress-deformation relations for concrete under loads even exceeding designing loads and loads applied in practice and up to 50 or 75 per cent of the ultimate strength may be represented by a straight line.

For a few specimens, composed of lean-mix or very wet-consistency concretes just removed from damp sand storage, it was found that the increments of deformation for equal increments of load for the first application of load only could be represented by an equation of the exponential type, but second and additional applications of load resulted in a straight line relation.

For ordinary working loads, and up to 50 to 70 per cent of the ultimate strength of the concrete, 95 per cent of the value for modulus of elasticity obtained by dividing the unit stress by the unit deformation for that load will represent the true modulus with sufficient accuracy.

The modulus of elasticity for normal concretes is the same for any given material in either the wet or dry condition.

The modulus of elasticity of concrete is apparently increased slightly for repeated or long-continued single applications of loads. The modulus of elasticity of concrete in a structure subjected to loads within design limits is probably slightly greater than the value found from tests of cylindrical specimens of the same concrete. The stress-deformation relation under such conditions can be represented by a straight line.

With any given cement and grading of aggregate of the same maximum size, and for any given proportion of cement to aggregate, the ratio of modulus of elasticity to compressive strength of concrete is fairly constant, regardless of the consistency or flowability.

Present Construction Costs and Corresponding Office Building Rentals

In an informal talk at the recent Pacific Northwest Conference at Seattle, Mr. Robt. G. Walker, manager of the Tacomah Bldg., Tacoma, Wash., made the following observation on rentals of office buildings under the present high cost of building.

The present cost of building is greater than at any time in the history of the country. The two factors that enter into the cost of building, namely labor and material, are vying with each other in the upward flight. Materials that enter into the construction of a building have increased from 60 per cent to 300 per cent. Labor demands more pay, shorter hours and is less efficient and the net result is that the cost of building has increased, on an average throughout the country 75 per cent since 1914, and what is more the cost of labor and building material holds little promise of reduction.

Many investors who ordinarily are able and willing to put money into building enterprises are holding off, hoping that prices will drop. But according to the best informed, there seems to be no relief for the next five years. In the meantime architects and contracting engineers are working continually to devise new and cheaper processes of construction. Notwithstanding the increased cost, according to figures, reports from 193 cities show the total of building permits for January, 1920, to be $117,747,000, as against a total of $21,732,000 for the same municipalities in January of 1919—a gain of over 440 per cent.

It is interesting to note that of this total building outlay 39 per cent was for industrial plants while 15 per cent was for business buildings. The city of Tacoma is building more large office buildings and business blocks this year than ever before in her history in spite of the high cost of construction.

The owner of a building erected eight years ago must meet a 75 per cent increase in operating expenses, while the owner of a building built at the present time must also meet an increase of 75 per cent in cost of construction.

It is a comparatively simple matter to figure out what the square foot rental of an office building should be to return to the owner 6 per cent [illegible] on his investment, but if this rule is adhered to it is apparent that the building constructed under present conditions must command a much higher rental rate than the [illegible] erected in prewar times.

From the standpoint of building [illegible], the building of today must command a [illegible] higher rental than the building of six or eight years ago. Can the owner of the new building overcome this [illegible]? Either the older buildings (not the obsolete ones) must profit by the present high cost of building or the owners of new buildings must be content with a very low return on their investments. The increase in the cost of construction does not give a better building, and the building of six or eight years ago can hardly be said to be obsolete or even to have depreciated 12 or 16 per cent, although as a matter of bookkeeping we may have charged 2 per cent per annum for obsolescence. In other words, your $600,000 building of six years ago is about equal to your $1,000,000 building of today.

This being the case, is the owner of a building constructed in pre-war times warranted in raising rents to the same high standard which the owner of a building built under present conditions must maintain in order that he may receive a fair return on his investment? This question may be answered by saying that this cause alone does not justify the raise, but there is another cause that does justify an equal or greater raise in rents and that is the ever increasing cost of operation. Whatever the cause, the building owner is entitled to a fair return on his investment.

The result will probably be that both causes will influence rentals to the end that the rate established will be a compromise; that is, the older building will be able to charge a higher rate than would be possible in the absence of the increased cost of building, while the new building will not receive the rate to which it may be fairly entitled because the older building can quote a lower rate and still show the same net return.

Buildings constructed at the present time in the smaller cities and on low priced lots will be entitled to charge a higher per cent of increase than will buildings in the larger cities built on land of higher value. Therefore the lower the ratio of land value to the cost of the building, the higher must be the rate of the rental increase on the total investment.

In the case of the Tacoma building, an increase in rents of 80 per cent over the schedule in force eight years ago would be justified, regardless of the present high cost of building, for then the building would earn not more than 6 per cent net on the original investment, allowing 2 per cent for depreciation and obsolescence. As a matter of fact we have increased our rents only 20 per cent in eight years.

We often hear it said that because building cost has advanced 75 per cent rents must be advanced 75 per cent to correspond. This conclusion, of course, is incorrect. Assuming that the land value remains the same, the proper rate of rental increase should be based on increased cost of building and on increase in operation and overhead.

For example: an office building costing $600,000 in 1911 is located on land valued at $500,000, making an original investment of $1,100,000. The same building would cost today $1,000,000 (land values assumed to be the same) increasing the total investment by 37 per cent or up to $1,500,000, which allows for 75 per cent increase in the cost of the building. To meet this increase in cost of building an increase in rents of 40 per cent is necessary. This means that rents should be advanced from $1.50 to $2.10 per square foot or in like ratio. Remember that this increase is in addition to the increase necessary on account of the increased cost of operation.

Rubber Bands as Draftsman's Aids. The common rubber band is one of the handiest of a draftsman's accessories, states the American Machinist. A small band wound around pencils, penholders, etc., will keep them from rolling off the board, and save many a broken point. Three such bands wound around the corners of a triangle, notches having been cut in the wood to hold them from slipping, will raise the triangle above the surface of a tracing and reduce risk of smudging. A larger band or two, and a piece of cord serve to hold the head of the T-square always in contact with the edge of the drawing board, the device being attached to the under side of the square and board by tacks.

A Plea for a Fair Contract*

By S. M. SWAAB

President Philadelphia Section, American Society of Civil Engineers

According to B[illegible] sufficient consideration to do or [illegible] held to be binding, of all contracts there should evidently be a mutual understanding and a meeting of the minds of the contracting parties as to the exact agreement.

Ambiguous specifications or [illegible] amount to the same thing. When the party for whom the work is being done doesn't know exactly what he wants and consequently doesn't show it on his plans nor describe it in his specifications, and when the contractor doesn't know exactly what he is agreeing to furnish, there is evidently not a meeting of the minds and there is plenty of room for argument.

This brings to my mind a case which was tried in one of our local courts involving the interpretation of a Pennsylvania statute. A Philadelphia lawyer, a former member of the state legislature, objected to his opponent's interpretation of the statute in question and appealed to the judge, making the statement that he knew better than his opponent what was meant by the law, having been its author. The judge wittily remarked, "Mr. — —, you doubtless know exactly what you had in mind, but it doesn't appear to have been written into the law in the way you wish it interpreted." The opposing counsel, who is now a member of the Supreme Court of Pennsylvania, interpreted the law in the only possible way it could have been interpreted, and that was exactly as it was written and was upheld by the court.

I recall an instance in which a certain gentleman, chief engineer of a big municipal department, made the statement, "when I prepared the specifications I had such and such in mind," and of a man who answered him, "when I read the specifications I had such and such an impression." As long as two men can be as far apart as this, it is evident that there can be no such thing as a mutual understanding.

What Should Be Set Forth on the Plans and Specifications?—Everything that is required to be included in the bid price should be so clearly set forth on the plans and in the specifications, that there shall be no possibility of any difference of opinion on the one hand as to what the owner is to receive and on the other hand what the contractor is to furnish. There is no question but that this can be done if sufficient care is exercised in the investigation before making the plans and in the subsequent preparation of the plans and the specifications. Evidently the contractor cannot be as familiar with the work as are the engineers who prepared the plans and specifications and he should therefore not be expected to read into them anything not definitely shown thereon nor described. Mind reading is not one of the usual accomplishments of contractors.

The Chief Engineer. The engineer is or should be an upstanding, intelligent, high minded, well balanced, more than ordinarily honest individual who, unlike physicians and lawyers who bury or intern their mistakes, as the case may be, has to stand for them and no doubt they stare him in the face and he is usually held to strict accountability for his every action, but this should not cause him to whimper nor to depart to the slightest extent from the path of exact justice, regardless of the way it affects the side which employs him or the other side.

The Scope of the Engineer's Duties.—Of the work of the engineer some one has said that "the gradual evolution of the status of the engineer has forced him to take account of other laws and forces than those of mathematics and pure science, so that today he is compelled almost without realizing it to consider economic problems and particularly those arising out of a proper appraisal of equity between man and man." This would clearly indicate that he has grown to be a much bigger man than formerly, where his work was largely of a technical nature.

The Contractor. The contractor, whether an engineer or not, is not necessarily a different kind of person from the engineer who has no contractual affiliations. They are both of them accounted as of the species "Homo Sapiens." The contractor has undoubtedly the same shortcomings as other men and possibly also participates with the engineer in the possession of those qualities which are sometimes designated commendable.

---

*From the July Journal of the Engineers' Club of Philadelphia.

Whether or not the engineer is justified in holding himself aloof from the contractor because he feels that he is of a higher grade of organization, hasn't at all been proven, for in the strictest sense, i. e., according to the etymological meaning of the word, there are comparatively few persons even including those whom we esteem most highly to whom this designation "contractor" cannot be applied

With this preface, let us proceed to a consideration of the subject

Whatsoever ye would that men should do to you, do ye even so unto them.

This may seem to be a peculiar theme for an engineer, but it is proposed in the light of this admonition to examine into the subject of engineering specifications and compare, if possible, the rights and the obligations of the engineer and the contractor.

Interpretation of the Specifications. The question has often been asked how and in what manner shall the specifications be interpreted. In answering this question were we to revert in this as in many other of the ordinary affairs of man to that vast storehouse of Hebrew law and lore designated the Talmud, we should read therein injunctions against holding any of the mandates of man or what may be otherwise termed man-made laws as immutable, as in the case of nature's laws.

"Laws that hang on hairs" is the method of expression used therein and this has been interpreted by the initiated to mean the reading of a law in the letter, rather than in the spirit, thereby making the law a burden to the people. To quote from a somewhat more familiar source, it is stated in the Second Epistle to the Corinthians, Chapter 3, Verse 6, "not of the letter, but of the spirit; for the letter killeth but the spirit keepeth alive."

The peculiar thing about engineering specifications and the feature in which they differ from any other code of laws is that they are usually prepared and written and put into operation and also interpreted by the same person and in many instances it is an integral part of them that he (the chief engineer) is the sole interpreter in case of dispute and his decisions are final, binding and conclusive on all concerned.

We know, however, that this clause, while it was probably written with the charitable view of having a formidable club to hold over the head of a recalcitrant contractor and has on many occasions been used for that purpose, has little or no standing in law, as it is beyond dispute that any action involving the disposition of a man's rights or his fortune is always subject to review by the courts, unless in signing a contract his inalienable rights recognized and guaranteed by the Magna Charta and the Bill of Rights is set aside by the contractor, which of course is preposterous to suppose and is in fact impossible. It is ooly by due process of law that many of the powers exercised unchallenged by the chief engineer under the specifications can be rightfully practiced, and the only reason why the law is not more often invoked in these matters is because of the fact of its being a cumbersome and expensive process and because the attendant loss of time and generally individual comfort and sometimes caste involved in any action at law is often considered of more value than the money at stake.

Method of Construction Not Usually Prescribed.—The construction program of the various processes used in the actual performance of the work is seldom prescribed in the specifications. This is because an ordinary structure, properly designed, should adapt itself to the ordinary and usual methods of construction. Extraordinary structures or engineering works of great complexity and magnitude, may require extraordinary treatment, but the methods of construction should always be foremost in the mind of the designer or he may design a work which cannot readily be built. This of course is said with the distinct understanding that regardless of the design almost anything can be built if time and money are not restricted

Function of the Engineer.—The accepted function of the engineer seems to be to determine the character and style of the finished work regardless of how that end is to be reached, i. e., without regard to the means employed to produce it. To elucidate the plans by describing what cannot readily be depicted thereon and to describe the physical characteristics of the materials of construction and also all of the extraneous matter relating to methods of payment and inspection, etc., which cannot readily be written in the contract, is taken to be the function of the ordinary engineering specifications.

In spite of all that may be said, the method of procedure which it is needless to say is of the first importance in the construction of any work, is usually left to the ingenuity and discretion of the contractor.

The term "engineer" used in this paper refers particularly to the chief engineer for the owner and the process of supplying the ingenuity and discretion herein mentioned, is usually a function of the contractor's engineer.

Comparison of Duties of the Engineer for the Owner and Engineer for the Contractor.—In this connection the possible comparison between the chief engineer (designing engineer) and the contractor's engineer (construction engineer) is that a failure of judgment on the part of the former while no doubt something that he regrets, a failure of judgment on the part of the latter, as a rule, will result in financial loss to his principals, possibly also loss of life, not to mention the chagrin at the loss of his position among his professional brethren, or any combination of these. In other words, the construction engineer is required to make the designing engineer's ideas possible and to back his judgment with his money.

Unquestionably this is not as it should be. The owner who expects to reap whatever benefits accrue from a structure or an engineering work of any magnitude whatever should take all of the risks incumbent in the construction thereof and should not attempt to shift the responsibility on the contractor; otherwise the art of contracting is degraded and rather than being legitimate, partakes of the nature of gambling, which should not be countenanced. On the other hand, if the contractor is to determine the feasibility of any structure or of any project whatever and is in fact to act as consulting engineer, his status should be fixed and he should be duly accredited.

Relations of Engineer and Contractor.—Regarding the relations of the chief engineer for the owner and the contractor, and this of course includes his organization, there can be little doubt that they are reciprocal and so inter-related as not to permit of separation on distinct lines. Probably one of the main functions of the contractor and one of the least appreciated by the general public, is that he usually points out the way to the engineer and his principals to enable them to accomplish the object they have in view with a given expenditure. Particularly is this true of unprecedented work. There is seldom a large piece of work attempted without first consulting with contractors with a view to learning their views as to its feasibility and practicability.

The question has often been asked why it is that with the tremendous increase in the cost of labor and materials which we are now paying, the bid prices for large contract work of a general character to include earth work, concrete, masonry, steel construction, etc., are not increased in the same ratio. The answer is probably more simple than would appear at first sight.

Contractor, Not the Engineer, Required to Devise New Methods of Construction. One of the compensations for the stress and hardship of the times is that the contractors' wits are sharpened by these arduous conditions and he is producing and probably will continue to produce methods and means for doing old things in new ways, both better and cheaper. The old adage is as true today as ever that "necessity is the mother of invention." The contractor is invariably required to invent, so to speak, or to discover, and in fact in most instances succeeds in devising ways and means permitting of more economical construction by new and sometimes untried methods. It may entail some hardship to make the confession, but it is a fact nevertheless that where ordinary methods can be used to advantage, the contractor only on rare occasions attempts to do anything that is extraordinary or to take any undue chances, but there is no doubt of the fact that his wits are sharpened by adversity and due to the abnormal increases in the cost of labor and materials, his ingenuity has been and will continue to be taxed to the utmost in the future to devise more economical methods of construction.

If, for instance, it were required [illegible] a Panama Canal today, it is undoubtedly a fact [illegible] much more of the work would be done by the process [illegible] dredging than with the steam shovel, for regardless [illegible] the improvements of the latter or how economically [illegible] can handle material, there is no question of the [illegible] where the material is suitable it can be pumped [illegible] than 20 per cent the cost by the dry process.

A few years ago had it been [illegible] a steel bridge or in fact any kind of a [illegible] the ordinary process of driving out the pins [illegible] probably long since rusted fast and cutting with [illegible] would have been practiced but by means [illegible] flame we can do 20 times the work [illegible] with a whole lot less effort and consequent [illegible]

In strictly modern underpinning [illegible] the size or character of the buildings to be [illegible] the process of needling has been superseded [illegible] at least one-third and probably as much as half the entire [illegible] of the work is saved.

Powder is used today for purposes [illegible] of a few years ago.

I have personal knowledge of a piece of work in which its use was substituted for the usual [illegible] of sledging, wedging, plug and feathering, etc., for the removal of rubble stone, brick and concrete foundations under a heavy building, a use to which it had not heretofore been put, at least on an extensive scale, and the saving of the time involved and therefore the cost over the old methods that had been used was simply tremendous.

There was completed late last year a piece of work of great magnitude, complexity and hazard in this city, which because of the unpropitious times inflicted untold hardship on the contractors, but the stress of war and the possibility of great financial loss staring them in the face, is what urged them on and made possible many of the schemes and methods, some of them entirely new at least in their application, which were devised by scientifically meeting the conditions, commercial, technical and financial, with which they were confronted.

The placing of concrete by the pneumatic process from a central plant, premoulded concrete and probably as the last step, figuratively speaking, concrete without forms, the use of the drill carriage in rock tunnel work, the jap drill, mechanical mucking and tunneling machines, methods of mechanically handling materials, motor truck haulage and modern methods of cost-keeping enabling one to have a better line on his work than was formerly possible and proper and efficient systems of organization of the construction forces, whether on the lines of scientific management or otherwise, all of which processes and many more unknown and unheard of at the present time will be invoked in the process of cost reduction.

Responsibility of Contractor. One of the questions in which contractors are much interested is whether, particularly in the case of a municipality, bids can be [illegible] for work of any character, without providing a [illegible] design for the same, the department reserving the right to approve the design of the contractor without recourse, at the same time distinctly specifying the contractor's responsibility for both the design and the integrity of the work after it is built, and all of this in the face of the [illegible] that it is pretended that the legal requirements have been complied with in receipt of competitive bids.

In the first place it is a fact that [illegible] in the sense that this is usually understood, cannot be had where each of several contractors is bidding on his own design, for without doubt these may vary [illegible] and this also affects the legal rather than the [illegible] side of the proposition, where the design is [illegible] by the contractor and approved by the engineer [illegible] though the engineer disclaims liability, it is [illegible] that the courts will take the same view, as it is [illegible] that the engineer's sanction, if it means anything [illegible] tacit acceptance of the design as his own. [illegible] bids are asked for a completed piece of work [illegible] specifically stated that the contractor is to design [illegible] place the liability entirely on the contractor.

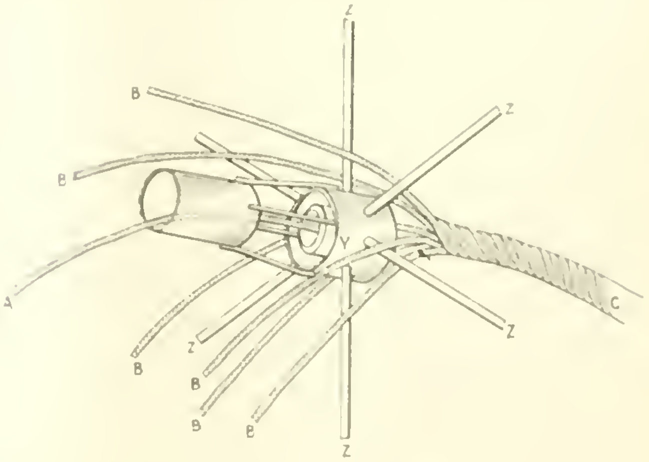
This is a very broad subject and what I have presented only in merest outline, has been with the view to induce debate and to bring out discussion. It will be observed that the basic principles involved are those requiring the exercise of common [illegible] the [illegible] or what in more polite language [illegible] the observance of the Golden Rule and the practice of [illegible] rather than law.

If all of the differences [illegible] of engineering contracts cannot be disposed of [illegible] with the specifications as amplified or rather [illegible] these principles without recourse to law, there must [illegible] be something wrong with the [illegible] as these principles are concerned at least [illegible] has demonstrated that they are the pillars on which is supported the entire moral fabric which evidently should govern the dealings between man and man.

Simple Device for Stripping Out Inner Strand of Steel Cable

An interesting salvaging operation was recently carried out very successfully by the Spanish-American Iron Co., a subsidiary of the Bethlehem Steel Corporation, in Cuba. The inner strand of a 3-in. steel cable which had been condemned and discarded because of worn and frayed outer strands was salvaged and the worn strands cut into 6-ft. lengths for the charging box. Both the inner strand and the scrap were well worth saving, as the cable was 1¼ miles in length and the reclaimed strand (1¼ in. in diameter) was practically as good as new.

The problem involved was to cut away the six worn strands without damaging the valuable inner strand. This was accomplished by means of a simple but ingenious device constructed on the ground out of convenient scrap metal. Suitable lengths of iron pipe, of a size convenient to grip with the hand, were oxwelded into the rim of a small iron pulley in such manner as to resemble spokes in the hub of a wheel with tire and felloes missing. A short section of sheet iron pipe, slightly smaller in diameter than the pulley but larger than the shaft bore, was then welded to it in line with the bore by the use of four strips of strap iron.*



Device for Strippinn Out Inner Strand of Cable.

The strands of the cable were then pried apart for a few feet to admit of passing the inner strand through the hub and its extension and the feeding of the outer strands through the six spaces between the spokes. With the strands so adjusted the device was revolved against the wind of the cable and advanced as the strands unwound, the inner strand being allowed to lie in a continuous length along the course of the work and the worn members being easily cut into charging box size with the oxy-acetylene torch. The length of the spokes gave the necessary leverage for hand operation of the device. The cable of course remained stationary, the inner strand being coiled and the scrap collected after the work was completed. The job was done in jig-time, the oxy-acetylene flame of the portable Oxweld outfit snipping off the worn strands with almost chopping speed.

---

*The use of the pulley and pipe extension was necessary only because a suitable length of pipe was not at hand. A single section of pipe of the right size to allow for welding in the spokes and long enough to keep the inner strand from curling would be much simpler and would serve the purpose equally as well.

The device is shown in detail in the accompanying figure "A" represents the inner strand of the cable; "B" the worn outer strands; "C" the body of the cable. "X" the pipe extension of the hub; "Y" the pulley used as hub; and "Z" the spokes. It was made with practically no cost for material, being composed entirely of scrap, and with little outlay for labor. It affords an interesting example of the resourcefulness of the American mechanic, John Cranford, who was in charge of the work.

Supporting Reactions in Pile Foundations and Batters for Railway Trestle Bents*

By CAPT. BILLINGS WILSON

The following is a theoretical discussion of supporting reactions in pile foundations and is submitted, not as an original study, but rather as a concise presentation of known conditions for the benefit of those engineers who have not previously considered the subject in detail.

The function of a pile is to transfer a concentrated load to the subsoil in a diminished unit concentration, or to carry the concentrated load through a soft strata to one capable of carrying the greater unit concentration. In doing his, skin friction exerts supporting power varying considerably with different kinds of soil, but apparently a variable function of the direct bearing value of the soil (the variable element being in most cases water content). As a pile is driven it creates a "cone of bearing" about itself, this cone diverging downward and its rate of divergence dependent on the relation of skin friction to bearing value in the particular soil. If piles are driven too close together, these cones overlap and consequently overload areas of subsoil and decrease the safe unit-pile supporting power. The writer recommends a minimum spacing of piles of 2 ft. 6 in. on the ground surface and a batter sufficient to prevent extensive overlapping of these "cones of bearing."

Batter serves two purposes: (1) to stiffen the bent against side thrust, thus assisting the sway bracing, and (2) to spread the foundation over sufficient bearing area, and at the same time have the heads of the piles close enough together to keep down the size of cap ncessary. (The first consideration is the more important in frame bents, and the second in pile bents.) A fair summary of observations and test reports at the writer's disposal, shows the following:

TABLE I.

Nature of subsoil	Direct bearing lb. sq. ft.	Skin friction lb. sq. ft.	Average Ratio DB to SF	Average Ratio SF to DB
Soft River Mud	400- 800	360	1.66	.602
Marsh	800- 1,800	600	2.16	.463
Alluvial Mud	1,600- 4,000	800	3.50	.286
Stiff Clay	8,000-12,000	1,800	5.55	.180
Sand unstratified	4,000-12,000	1,000-2,000	4.00	.250
Sand stratified "in situ"	12,000-18,000	2,000-5,000	4.80	.208

The last column represents the theoretical square feet of subsoil under load outside the perimeter of the pile, the load being transferred to this area by the skin friction on 1 sq. ft. of pile surface.

Assume, for purposes of comparison, a pile with a 9-in. tip driven to 20 ft. penetration, the diameter of the pile at the surface of the ground being 15 in. The surface area of the pile in contact with the soil will then be 63 sq. ft. and by simple computations we obtain the following:

TABLE II.

Nature of subsoil	Area of indirect bearing, sq. ft.	Area of direct bearing, sq. ft.	Total area of bearing (base of "cone of bearing") sq. ft.	Diameter of "cone of bearing" ft. in.	Batter of cone surface per vertical ft.
Soft River Mud	[illegible]	1.2	[illegible]	7 1	1¾ in.
Marsh	[illegible]	1.2	[illegible]	6 3	1½ in.
Alluvial Mud	18.0	1.2	[illegible]	5 0	1⅛ in.
Stiff Clay	11.4	1.2	12.6	4 0	¾ in.
Sand unstratified	15.8	1.2	17.0	4 8	1 in.
Sand stratified	[illegible]	1.2	14.3	4 3	¾ in.

In Table II Column 1 represents the subsoil area in bearing as a result of transfer of load from the pile by skin friction. Column 2 is the subsoil area in direct bearing, being the vertical projection of the cross sectional area of the pile at the ground surface. Column 3 is the sum of Columns 1 and 2, and represents the area of "spread footing." Column 4 gives the diameter of the circles whose areas are given in Column 3. The last column is the slope of the surface of cones 20 ft. high with base diameters those in Column 4. This last column represents the theoretical difference in batter required between any two adjacent piles to avoid overloading any portion of the subsoil. Since the load carried by a pile can only be transferred to soil outside of the perimeter of the pile by skin friction, it follows that the higher the supporting power of the subsoil the less the area of the cone of bearing required to support the load transferred away from the pile by skin friction. And conversely, in the softer and more fluid soils, where skin friction is a more important supporting factor, a larger cone of bearing is required to support the same load. These cones of bearing must not be confused with the truncated cones of direct bearing underneath, and inside the perimeter, of the pile. The divergence of the load in these latter cones is simply that of the ordinary reaction of a soil to a superimposed load and is a fairly well known function of the coefficient of friction of the individual particles in the soil.

In railroad trestles, or in any pile support where all the piles are driven in one plane and no other piles driven alongside within say 10 ft., it is permissible and better to allow the bases of the "cones of bearing" to overlap slightly. This will reduce the amount of batter required and diminish the spacing of the piles, making for more economical construction. Also the percentage of overlapping area in each cone base is relatively small when the combined middle ordinate does not exceed 1 foot (being about 14 per cent in stiff clay, and 6 per cent in soft mud).

In cases where very deep penetration is necessary to obtain a sufficiently large and, at the same time, safe supporting power for a pile, it is evident that the foregoing theory would demand abnormal batters or rather large pile spacings. (By "very deep penetration" is meant penetration over 70 ft.) In these cases, almost invariably, there is a great deal of water in the subsoil and the foregoing values for direct bearing and skin friction do not apply. It is probable in this class of foundation that there is little, if any, load transferred from the pile to the subsoil in the upper quarter of its length and that the rate of transfer in the lower three quarters is considerably less than any values derived hereinbefore. This would mean a steeper "cone of bearing" than any here worked out, with a consequently smaller allowable pile spacing and batter. Reliable data on pile supports in soil of this character being exceedingly limited, it is difficult to predict, in a purely theoreticl discussion, the nature and amounts of the subsoil reactions. Test piles must be driven, not singly but preferably in groups of three or four, and loaded as a group, to derive a safe working figure for the foundation support as a whole.

Based on the foregoing theoretical discussion and certain practical considerations, the following batters are recommended for railway trestle bents in average soils—

4—Pile bents (spacing, 2½, 3, 2½ ft.).
  2 inside piles plumb.
  2 outside piles battered 2½ in.; 12 in.

5—Pile bents (spacing 2¼, 2½, 2½ ft.).
  Center pile plumb.
  2 intermediate piles battered 1 in.; 12 in.
  2 outside piles battered 2½ in.; 12 in.

6—Pile bents (spacing 2¼, 2½, 2½, 2½, 2¼ ft.).
  2 center piles plumb.
  2 intermediate piles battered 1 in.; 12 in.
  2 outside piles battered 2½ in.; 12 in.

Missouri Drainage Districts Must Pay for Bridges.—The Supreme Court of Missouri on July 16 handed down a decision holding that the cost of bridges, where made necessary by drainage districts, must be paid for by the special drainage districts' land. To this end, such districts may vote special levies. In the past the cost of these bridges has been paid by the counties.

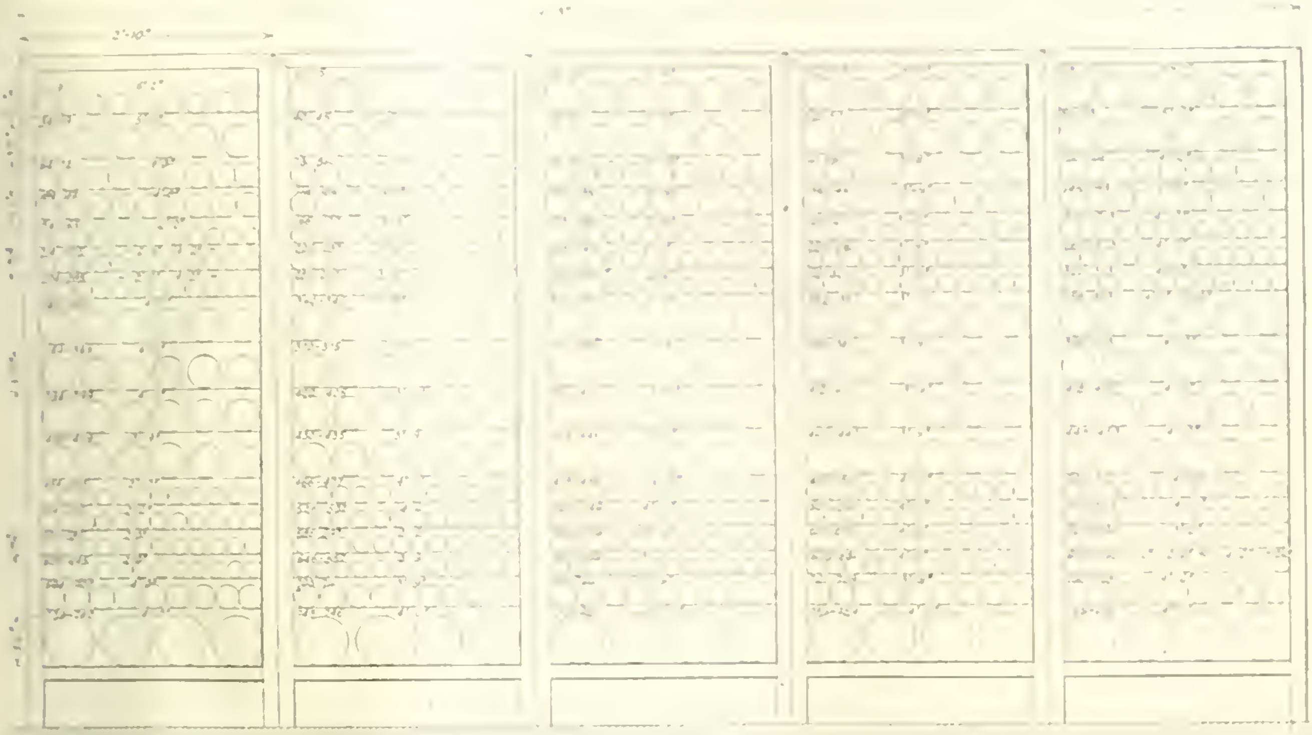
---

*[illegible] an article entitled "Railroad Trestle Building in Military [illegible]" in the current issue of The Military Engineer.

Map Filing System of Kingston Coal Co.

An excellent map filing system [illegible] by the Kingston Coal Mining Co. of Kingston [illegible] The following particulars are taken from the Coal [illegible]

The drafting room of this company [illegible] light and airy, and has plenty of space for [illegible] in use. In fact, should the necessity arise [illegible] sufficient room without overcrowding to install in [illegible] A row of four double windows extends down each [illegible] while one large window is placed at either [illegible] heat keeps the room at a comfortable temperature during the winter while electric fans in summer tend to alleviate excessive heat. For night work sufficient artificial light is provided by means of adjustable drop lamps. The floor is covered with large blocks of cork, thus relieving the strain of the draftsmen, who, being compelled to be on their feet throughout the day, naturally find the work tiring. The cork floor also deadens the noise made in moving about.



Arrangement of Maps in Filing Case Contained in the Vault.

The offices of the Kingston Coal Co. are located over the station of the Delaware, Lackawanna & Western R. R. in Kingston, and as a result dust and cinders enter the building in quantity. Dust settles over everything, tending to ruin or destroy the maps and drawings. Some method had to be devised to protect these records, for even when they were placed in the vault the dust would come through the open door and settle on them.

The vault itself is of the ordinary type of construction and is about 15 ft. square. It affords more than sufficient room for the accommodation of all the drawings up to date and it provides ample space for those which may have to be filed in the future. At present the filing case contains space for 758 individual drawings, provided only one drawing is filed in each compartment. This filing case is about 5 ft. high and 11 ft. 3 in. long and is built along the rear of the vault. Two-inch angle iron is used in the construction of the filing case. Six vertical bars divide the case into five equal divisions. Horizontal cross bars of ½-in. round iron are used to support the individual compartments.

Round tin tubes of various sizes and lengths are used as individual drawing containers. The opening of the tubes is made on a slant and is so arranged that the flap cover, which also is of tin, will always stay closed unless it is purposely held open. These flaps are made as nearly airtight as possible and thus the dust is prevented from entering the tubes and destroying the maps. Tubes of four different diameters [illegible] of six different lengths [illegible] following combination of tubes:

No.	Diameter	Length	[illegible]	[illegible]	Length
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The above combinations can be varied to suit the conditions at the mines; the number of each size could be increased or decreased at will. Many other changes can be made to suit conditions that arise.

Each of the tubes has a flat [illegible] fastened to the bottom at the point where the horizontal rods come in contact with it. These lugs are used to hold the tubes in their proper place in the rack.

A New High Speed Ball Bearing Screw Jack for Heavy Lifting

Several novel features of construction are embodied in the latest design of Duff high-speed ball-bearing screw jack, a tool which is particularly adapted for bridge work and other purposes where a lifting capacity of 50 and 75 tons is required.

The most noticable thing is the fact that the operating mechanism, instead of being located in the head, is placed in the base. The greater weight is thus put at the bottom instead of at the top, so that the jack is not top-heavy. Another advantage is that the point at which the operating lever is pivoted does not rise with the load. This allows a full, powerful stroke, regardless of the height of the load.

This newly designed jack is unusually easy to move about. Not only does the concentration of weight in the base make it easy to handle, but by inserting the operating lever in special sockets, the jack can be tipped over by one man and rolled on its own sturdy wheels wherever needed.

The load is raised by means of a 6-ft. steel lever which operates a double-thread screw through a ratchet and gearing. The screw has a very steep pitch, making the action extremely rapid. The screw is made of special machinery steel, heat treated, and turns in a bronze nut of special composition. This combination of bronze and hard steel materially reduces friction.

Absolute safety is stated to be assured by a positive clutch which holds the load at all times, preventing any possibility of it sinking or lowering. Another safety feature is the signal which is provided to indicate when the jack has reached its maximum height.

For lowering, a crank handle is used. A few easy turns are all that are required as the action is very rapid. Regardless of the speed with which the load may be descending, it is claimed that it may be stopped with absolute safety at any point desired. The action is positive, so there is no possibility of sticking.

This new high-speed ball-bearing screw jack, built by the Duff Manufacturing Co., of Pittsburgh, is made in two capacities, 50 and 75 tons maximum. Both the 50 and the 75-ton jack are supplied in a variety of heights to suit requirements.

New Duff High Speed Ball Bearing Screw Jack.

Revision of Weights for Sections of Minimum Web Thickness of American Standard Beams and Channels

In 1896 the Association of American Steel Manufacturers adopted a list of standard profiles of structural steel sections which are known as American Standard Structural Sections. In 1911 the Association also adopted standard methods of computation for published weights and areas. The weights that were published for the minimum thicknesses of beams and channels did not correspond exactly to the published areas and it has long been known that it is impracticable to furnish these sections true to both the published weights and dimensions.

To correct this situation the Association has just adopted as American standards the weights per foot shown in the third column of the table below for the sections of minimum web thicknesses which do correspond to the published dimensions.

Section.	Depth, ins.	Weight, pounds per foot— Present weight.	New weight.
Beams	3	5.5	5.7
	4	7.5	7.7
	5	9.75	10.0
	6	12.25	12.5
	7	15.0	15.3
	8	18.0	18.4
	9	21.0	21.8
	10	25.0	25.4
	12	31.5	31.8
	12	40.0	40.8
	15	42.0	42.9
	15	60.0	60.8
	15	80.0	81.3
	18	55.0	54.7
	20	65	65.4
	20	80.0	81.4
	24	80.0	79.9
	24	105.0	105.9
Channels	3	4.0	4.1
	4	5.25	5.4
	5	6.5	6.7
	6	8.0	8.2
	7	9.75	9.8
	8	11.25	11.5
	9	13.25	13.4
	10	15.0	15.3
	12	20.5	20.7
	15	33.0	33.9

There is to be no change in the profiles and properties of sections of minimum web thickness nor in the weights and properties of the intermediate and maximum sections of American Standard Beams and Channels.

The new weights are to be put into effect Sept. 1 by all of the companies rolling these sections.

Labor Requirements for Various Crops.—The approximate amount of labor required to raise some of the more important crops has been determined by recent farm studies conducted by the Office of Farm Management, U. S. Department of Agriculture. The results show that it requires the work of one man and one horse for a 10-hour day to cut, cure, and harvest an acre of hay. Oats, wheat, barley, rye, buckwheat, and millet consume more labor; under normal conditions these grains require the labor of a man for 2 days and for the horse 3 days. Corn for the silo in the Central States consumes 3 days of man labor and 5.5 of horse work. Tobacco in Kentucky uses 35 days of man labor against 8 days for the farm horse, but onions, as determined through studies in Ohio, sold in bunches, top the list of vegetables in the amount of man labor they require. Onions use 149 days of man work, but only 10 of horse work. Beets and carrots, also sold in bunches, come next, with 82 man-days to each acre and 8 days' horse labor. It is interesting to note that a horse, in the Eastern States, requires 12 ten-hour days per year from his master to care for him, and he contributes only three-quarters of one day to his own upkeep—hauling feed, etc. Dairy cows need 18 days from the man and 2 from his horse each year.

Industrial Notes

Barton Spider-Web System, Chicago, Ill.—Announcement is made that architects and engineers are being licensed to use patented improved methods for "two way" and "four way" reinforced concrete flat slab construction. It is stated that this combination consists of running bottom slab bars both diagonally and directly between columns, while steel in top of slab, over column head, extends in two directions only. Top steel may consist either of fabricated units, loose bar units, or bent up ends of bottom slab steel belts extending directly between columns.

Protexol Corporation, New York, N. Y.—Announcement is made of a consolidation with the Carbolineum Wood Preserving Co. under the name of the Protexol Corporation, 34 Barclay St., New York. The officers of the new company are substantially the same as those of the Carbolineum Wood Preserving Co., and the export department is in charge of Mr. Fred Jaeger. An extensive coal tar products plant has been erected at Kenilworth, N. J., for production of the company's "Protexol," "Anolineum," "Neosote," acids, oils and preservative materials.

New England Water Works Association.—Preliminary notice has been made of the 39th annual convention at Holyoke, Mass., Sept. 7-10, 1920. The office of the secretary will be open at Hotel Nonotuck at 8 a. m., Sept. 7. For information regarding hotel accommodation, address Mr. Patrick Gear, Supt. Water Works, Holyoke, Mass.

Southwest Water Works Association.—Notice of annual convention at St. Charles Hotel, New Orleans, La., Sept. 20 to 23, 1920, has been mailed. Applications for exhibits should be sent to Mr. Burt B. Hodgman, Chairman Water Works Manufacturers' Association, 50 Church St., New York.

Menominee Motor Truck Co., Clintonville, Wis.—Announcement is made of the completion of a new plant for the production of 1, 1½, 2, 3½ and 5 ton rear drive trucks.

Trade Publications

Wire Rope Slings for Industrial Plants.—John A. Roebling's Sons Co., Trenton, N. J. A comprehensive 72-page treatise illustrated with a wide variety of applications. Special diagrams show most efficient methods of application and are accompanied by detailed data tables covering maximum safe loads, etc.

Motor Trucks.—The Autocar Co., Ardmore, Pa., 12-page illustrated pamphlet showing in detail operation of special two-section bodies for use in road work, together with single body design specially adapted for asphalt, crushed stone and sand.

Reducing the Guess in Road Work.— Lakewood Engineering Co., Cleveland, Ohio. 18-page booklet describing plan of operation of complete line of road building equipment. Amplified with special illustrations and construction data.

Wire Rope.—A. Leschen & Sons Rope Co., St. Louis, Mo. 12-page monthly illustrated pamphlet devoted to applications and descriptions of "Hercules" wire rope in construction work.

Personals

Walter E. Miller, for the past fourteen years on the Wisconsin Railroad Commission, has resigned to engage in consulting practice at 413 Pioneer Block, Madison, Wis. His practice will include investigations and studies of steam and electric railway and public utility problems, especially the valuation of such properties, ratemaking therefor, reports on efficiency of operation, designing, estimating and supervising construction of new properties and improvements of existing plants.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., SEPTEMBER 1, 1920. Number 9.

A Highway Engineer Becomes a Highway Commissioner

Slowly the number of engineers who are members of state highway commissions is increasing. John N. Mackall, for example, has recently been appointed chairman of the State Roads Commission of Maryland. Mr. Mackall retains his position of Chief Engineer of the Commission.

This combination of duties—those of chairman and of chief engineer—seems to us an excellent arrangement for many a public commission.

It is to be hoped that engineering societies and clubs will take active steps to bring about the appointment of engineers to positions on all commissions that have jurisdiction over engineering work. Whenever a prospective or existing vacancy on such a commission comes to the attention of an engineer, he should notify his associates and urge the importance of co-operative action to secure the appointment of an engineer to fill the vacancy. Such action should not be confined to drawing resolutions and writing letters, but a committee of engineers should call upon the governor, mayor, or other appointing official. Word of mouth argument counts most in such cases.

In this connection it may be added that when nominations for elective commissions of this nature, such as county commissions, are about to be made, engineers should strive to secure the nomination of at least one engineer.

Why Wisconsin Road Improvement Has Been Delayed

Road construction has been curtailed in California because of inability to market their 4.5 per cent highway bonds, whereas in Wisconsin the reason for curtailment has been the inability to secure materials by rail. A. R. Hirst, Wisconsin State Highway Engineer, recently said:

> Unless there is a turn for the better soon I have about decided that we will abandon all efforts to build new highways involving the use of shipped-in materials in Wisconsin. The game is entirely too uncertain and too expensive. We are paying a premium of 10 to 25 per cent on every contract we let on account of the doubtful transportation situation and we now have roads torn up over all the state which it seems impossible that we can finish this year although our program of high-class construction was first cut from 400 to 200 miles, then to 125 miles, and we have now been hoping to complete 75 miles.

For reasons given in another editorial it is probable that the railway freight condition will improve rapidly. Nevertheless state and county highway commissioners and engineers should make an effort to persuade state public utility commissioners to take a keener interest in securing better freight service for construction purposes. Railway officials will naturally be inclined to give preference to freight that yields the largest revenue per car-mile, and construction materials do not fall within that class.

Confused Ideas About the Law of Supply and Demand

Most editors have at least a smattering knowledge of the contents of at least one book on political economy. But so crude are the majority of editorials on economic subjects that it is clear that few editors have given much study to even one elementary treatise on the subject. In this respect editors of technical periodicals are not so weak as editors of general magazines and daily papers. Nevertheless they frequently make statements that are almost childish in their crudity. As an example we quote a few sentences from a recent editorial in a scientific periodical:

> Much talk is made about the law of supply and demand, which is regarded, and is used as a universal and immutable principle that governs the price of things much as the law of gravitation governs their position and movements. The idea seems to be that the price moves in some fashion directly controlled by the excess of supply over demand or demand over supply. The supply, apparently, is to be assumed fixed and immutable at least until another producing season rolls around with its appeal to the producer to make more or less goods. When there is too great a supply,

demand must be stretched when there is too great a demand, again demand is to suffer the Procrustean process and be cut down.

In earlier and simpler days we have no doubt that this worked out very nicely. But today when we go through the motions of cutting down the effective demand, the effective demand simply refuses to be cut. We have a condition which appears entirely novel in that the consumer refuses to adjust his wants to the visible supply. If shoes are so scarce that the price doubles, according to all the rules of the game, the demand and the sale ought to be cut approximately in half. Are they? Emphatically, they are not.

We talk about the law of supply and demand. Then we go right out to the butcher and the grocer and the dry goods store and arbitrarily refuse to give the poor old law a chance to function. If supply can't be immediately adjusted and demand won't be, what can be expected save prices that really will operate to freeze out entirely those whose resources are least?

We have quoted about a third of the entire article, but enough is here given to show not only its general tenor but its prevailing weakness. To begin with, no book on economics announces any such "law of supply and demand" as this editor conjures out of his imagination.

Having shown to his own satisfaction that the "law of supply and demand" has ceased to "function," the editor urges us to make it "function" thus:

> Not until we begin to adjust our demand very generally and on a very earnest scale may we expect to see any material reduction in prices. If we will, as a nation, use old equipment of every sort until we have squeezed out the last drop of utility, and of the things that have to be bought buy the very poorest grade that will approximate satisfaction, we may hope for price adjustments.

The use of the word "function" as applied to a scientific "law" is, to put it mildly, a questionable use. A natural law is a concise statement of what occurs under given conditions. If the condition does not exist, the law does not apply; but it is very confusing, if not actually erroneous, to say that the law does not function.

Supply and demand are functions of one another, as was indicated in our issue of July 14. Hence to speak of supply as fixed and demand as flexible is not in accord with the facts or with any theory about the facts to be found in any book on economics.

Economic laws are often contrasted with physical laws, to the disparagement of the former. Yet any such belittling of economic laws discloses lack of understanding of the nature of scientific laws in general. Some physical laws are very exact, which is equivalent to saying that knowledge of the forces involved is very complete. Other physical laws are only approximately correct, which indicates incompleteness of knowledge as to the coacting forces. But no one would ridicule a physical law because of imperfection provided it were the nearest approach to the ideal that is yet available. Economic laws should be judged in similar manner.

Why Engineers Should Study Accounting

Committee No. 11 (on Economics) of the Society for the Promotion of Engineering Education reported adversely as to a special course in accounting for engineering students. The committee contends that "any intelligent technical graduate can read books on any of these subjects (special subjects in the economic group) understandingly without the aid of an instructor." This is true, but what reply can the committee make to the statement that very few engineers ever do master the practice of accounting?

Our own belief is that a thorough course in accounting and cost keeping should form part of every engineering course, partly because cost and profit recording are the basis of all economics. It is self-evident that the great majority of engineering graduates must eventually secure positions that are not of a purely professional nature. Hence little argument is needed to convince most engineers that at least the majority of engineers should study accounting.

But the committee replies that accounting can be learned after graduation. If ability to learn a subject after graduation is to be a criterion as to the advisability of teaching it in colleges, then our reply is that aside from the mathematics and theoretical mechanics there is scarcely a subject in present civil engineering courses that should not be eliminated.

If, on the other hand, the purposes of an undergraduate course in engineering are first to develop proper mental habits, and second, to open the doors to engineering knowledge, then accounting should be taught.

A training in accounting is an excellent means of developing precision, as well as the power to analyze costs. The average engineering graduate lacks both exactitude and a respect for it. He will glibly excuse an error by pointing out that he understands the theory but was merely hasty in his calculations! He is so much impressed with the importance of correct theory that he is apt to underrate the importance of exactitude in the application of theory. Now, the theory of accounting is relatively simple and readily learned, but the process of analyzing and properly recording costs is by no means so simple as it looks. The engineer who does not become habituated to accounting and cost keeping early in his career is apt never to become a thorough economist.

Better, then, to eliminate some of the structural designing, for example, and substitute a wholesome dose of accounting practice.

The Saskatchewan Road Dragging Competitions

In 1913 the Provincial Department of Highways of Saskatchewan, Canada, inaugurated a road drag competition for the purpose of inducing as many of the rural municipalities as possible to make a serious attempt to give the drag a thorough try-out. The result of these competitions were set forth by Mr. H. S. Carpenter, Deputy Minister of Highways, in a paper presented at the recent 7th Canadian Good Roads Convention.

There are 300 rural municipalities in Saskatchewan, and subject to certain established rules, the competition was open to each of these to make one entry of a stretch of road not less than 2 nor more than 6 miles long. This competition has been carried on every year since by the department. The number of entries received each year since the inception of the competition, the number of miles of road dragged and the average cost of dragging per mile for the season are as follows:

Year.	Entries.	Miles dragged.	Average Cost per mile.
1913	19	124	$11.86
1914	66	186	13.50
1915	48	145	16.83
1916	36	109	16.54
1917	29	126¼	13.11
1918	65	212¼	15.15
1919	67	228½	19.87
1920	140	560	

The average cost of dragging per mile per season is obtained from the returns which are made by each entrant as required by the rules. Mr. Carpenter is of the opinion that this figure is somewhat higher than is necessary to effect satisfactory results from dragging, as no doubt there is a tendency among the competitors to devote more time to the work in order to be placed on the prize list, than would otherwise be the case under ordinary conditions.

In 1914 requests were sent out to all the rural municipalities, to make returns to the department of drags in use in each municipality, the number of miles dragged that year, and the cost per mile. The returns showed that in that year there were in use 961 drags, 2,300 miles dragged at a total expenditure of $14,414 or an average cost of $6.28 per mile. A similar census taken in 1919 shows that there were then in use in the province 2,518 drags, 9,844 miles dragged at a total cost of $89,041 or an average cost per mile of $9.04. These figures for 1919 indicate that the 300 rural municipalities average only eight drags in operation for each municipality, dragging 33 miles.

1914 and 1920 Prices on Road Work.—The following statement from the July Idaho Highway Bulletin illustrates why roads cost more today than they did a short time ago. The figures are taken from contracts awarded in 1914 and those awarded recently:

	1914.	1920.	Per cent increase.
Excavation, earth, cu. yd.	$0.20	$0.65	225
Excavation, loose rock, cu. yd.	.60	1.25	108
Excavation, solid rock, cu. yd.	1.75	5.00	186
Overhaul, per 100 ft.	.02	.05	150
Gravel surfacing, in place, cu. yd.	1.50	5.50	267
Concrete, cu. yd.	10.00	35.00	250
Reinforcing steel, in place, lb.	.05	.12	110
Average increase			189

The Development of an Economic Theory of Highway Transportation

By ROBERT C. BARN[illegible]
Economic Engineer, Ka[illegible]

There is growing, among highway engineers, a fuller recognition of the need for an economic theory of highway transportation to serve as a guide in the framing of policies and to insure the judicious expenditure of the large sums now available for highway construction and of the larger sums to come in the near future. Indeed, the need for such a theory is so urgent and its importance so great that a concerted effort on the part of highway engineers should be made to bring about quickly its development. In furtherance of this object, the writer wishes to set forth the basis for such a development, to define the lines along which such development must proceed, and to show how far we may now go towards the formulation of an economic theory.

At the outset, it is essential to have an adequate and correct notion of just what an economic theory is and what it embraces. Therefore, as a preliminary to this state of mind, let the reader pass beyond the attitude of saying to himself that a certain result depends upon this factor and upon that, and of then resting content with his logic. Let him proceed one step further and ask himself how much does the result depend upon this factor and how much upon that. Then let him advance another step by noting that if the result is a desirable one, a maximum value is to be sought while for an undesirable result a minimum is the desideratum. Now let him follow this with the inquiry of what relations will obtain among all the factors when this desired maximum or minimum, as the case may be, result occur. Definite and complete answers to these questions will not be forthcoming at the outset, but the line of thought will put the reader in position to appreciate the value of quantitative thinking on the subject and will serve to clarify his ideas of what constitutes an economic theory.

In general, an economic theory is simply a definition of principles setting forth the relations that exist between cause and maximum effect. It is a formulation of criteria, or laws which state the exact inter-relations that must obtain between contributing factors in order that a desired maximum economy may be secured.

Fundamental Steps for Developing Economic Theory for Highway Transportation.—How then will we proceed to develop such a theory for highway transportation? The answer is foreshadowed in the preceding mental process.

As previously pointed out in these columns by the writer, there are four fudamental steps to be taken as follows:

1. To form a definite and complete concept of the objective—the result to be attained.
2. To determine and classify the various factors which produce or in any way affect the objective.
3. To determine the quantitative relation between each factor and the objective.
4. To determine from the aforesaid relations an inter-relation among the factors such that a maximum economy will result.

It is these inter-relations, or criteria, that form the essence of the economic theory.

This program for procedure is the basis of the proposed development. When completely developed our economic theory of highway transportation will set forth the basic factors and their derivatives which affect the cost of such transportation. It will show the quantitative relation between each factor and said cost. It will further indicate the inter-relations that obtain when a maximum is reached. These criteria will enable us to secure [illegible] and with certainty that adjustment of the factors which will produce the maximum economy. Without these criteria we are groping our way bunglingly towards a dimly perceived goal. It is pertinent, therefore, to ascertain how far we may now go towards formulating such a theory. Such an attempt will clearly reveal the missing links in our chain of data and will serve to crystallize better our ideas on a method for obtaining them.

What then is the specific result that we are seeking to attain in highway transportation? What are the factors contributing to that result?

Fundamentally, the problem presented is that of transporting over a highway a given annual tonnage between fixed points or stations at the lowest attainable cost. To produce this transportation there must be a roadway, vehicles and motive power. These three elements bear a relation to each other and to the annual tonnage. Each element has its own properties or characteristics. Let us consider briefly each one in [illegible].

The Roadway Element.—The roadway has length, breadth and grades. It cannot be shorter than the air line distance between the termini and, as a matter of fact, is usually longer. This excess distance admits of adjustment but in so doing other factors are affected.

The width of the roadway must be sufficient to safely accommodate the traffic which passes over it generally in distinct lines. The width required for one line of travel depends on the width of the vehicle using the road and upon its speed. The number of lines of traffic to be provided for will depend on the density of traffic or upon the number of vehicles passing a given point in a unit of time. In each line of travel each vehicle needs room enough for its own length and a sufficient headway in which to make a quick stop from maximum speed, plus a margin of safety. These conditions determine the allowable density of traffic per line of travel. The density of traffic due to a given annual tonnage divided by the allowable density per line gives the number of lines of travel to be allowed for in the establishment of the width of roadway. In addition to this space, however, there must be room for shoulders, drainage ditches and side slopes, but a variable amount will be required for the side slopes which depend upon the depth of cut or fill. Hence the right of way must have a width sufficient to afford space for the pavement, shoulders, side ditches, and side slopes for maximum cut or fill.

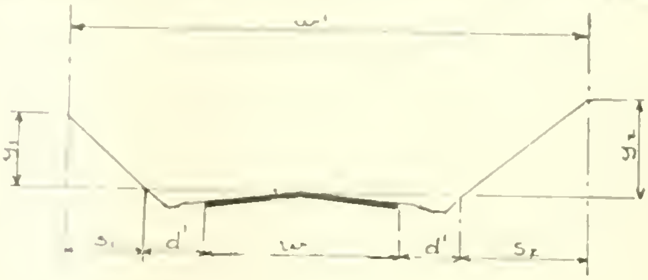


Fig. 1.

The grade line results from making certain cuts and fills. These are to be so adjusted that a maximum economy will result. They depend upon the profile of the ground line and upon the economic excess lift. A change in alignment usually encounters a different topography and a new ground line which in turn causes a variation in the cuts and fills, if a constant amount of excess lift is to be maintained. Also any change in alignment is apt to affect the excess distance factor.

The foregoing relations of the factors affecting the length, width, and grades of a road can be expressed with greater definiteness and precision in algebraic terms as follows:

Let L = length of road in miles
L = air line distance between termini
X = excess distance, then
$L = L + X_D$

Again let w = width of roadway in feet
d' = space for shoulder and ditch
s_1 = space for one side slope
s_2 = space for other side slope
w' = width of right of way; then
$w' = s_1 + 2d' + w + s_2$ (See Fig. 1.)

But $s_1 = a' y_1$ and $s_2 = a' y_2$. In turn y_1 and y_2 are dependent upon the excess lift as will be shown subsequently. Hence

$$y_1 = \frac{c' - X_L}{n}$$

and

$$y_2 = \frac{c'' - X_L}{n}$$

By using the formulas proposed by Mr. H. J. Fixmer*, w may be expressed in terms of the traffic, thus:

---

*Paving Engineer, Chicago.

Width required for one line of traffic $= b' + \frac{S}{10}$. In which

b = width of vehicle in feet

S = speed in miles per hour.

The number of lines of traffic to be provided for is equal to the given density of traffic divided by the allowable density. The density that a certain equipment of N vehicles, each making a round trip in h hours, can produce, is $\frac{2N}{h}$.

The allowable density of traffic as given by Fixmer's formula is

$$D_t = \frac{5280\,S}{2S^2_m + v_1}$$

in which

S_m = maximum speed in miles per hour, and

v_1 = length of vehicle in feet

D_t = number of vehicles passing per hour.

Hence the number of lines of travel—

$$\frac{\dfrac{2N}{h}}{\dfrac{5280\,S}{2S^2_m + v_1}} = \frac{2N(2S^2_m + v_1)}{5280\,Sh}.$$

but $N = \frac{T_aL}{KHS}$ and $h = \frac{L}{S}$ as shown later. Substituting these values in the formula for lines of travel, we have:

Number of lines of traffic $= \frac{T_a(2S^2_m + v_1)}{2640\,KHS}$. (Taken to the nearest integer.)

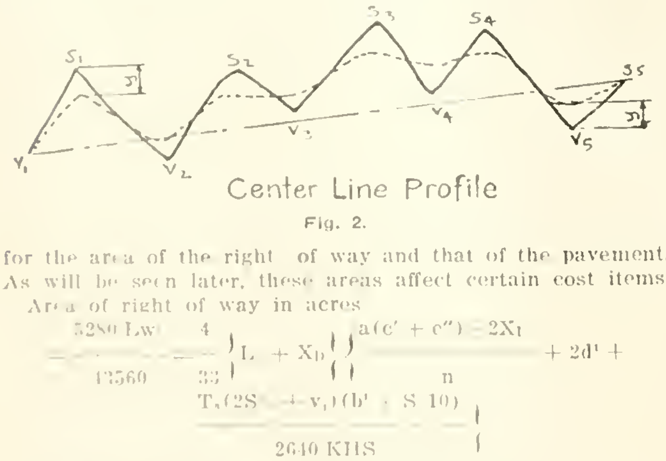
By substitution, the expression for width of roadway now becomes

$$w = \frac{T_a(2S^2_m + v_1)}{2640\,KHS}\left(b_1 + \frac{S}{10}\right)$$

Next by reverting to the formula for width of right of way, we may substitute these new equivalents and obtain an expression for same in terms of the fundamental factors, thus

$$w = \frac{a(c' + c'') - 2X_L}{n} + 2d^1 + \frac{T_a(2S^2_m + v_1)\left(b^1 + \dfrac{S}{10}\right)}{2640\,KHS}$$

From these values of w and w', together with the preceding formula for length of roadway, general equations are derived for the area of the right of way and that of the pavement. As will be seen later, these areas affect certain cost items.



Center Line Profile

Fig. 2.

Area of right of way in acres

$$= \frac{5280\,Lw'}{43560} = \frac{4}{33}\left\{\left(L + X_D\right)\left(\frac{a(c' + c'') - 2X_L}{n} + 2d^1 + \frac{T_a(2S^2_m + v_1)(b' + S/10)}{2640\,KHS}\right)\right\}$$

Area of pavement in square yards

$$= \frac{5280\,Lw}{9} = \frac{2(L + X_D)T_a(2S^2_m + v_1)\,(b' + S/10)}{9KHS}$$

The grades depend upon the depth of maximum cut or fill which in turn depends upon the ground line and upon the economic excess lift. In traversing the road, the load must be lifted from each valley to the adjoining summit. Excess lift is the difference between the total lift and the lift due to the difference in altitude of the termini. This will be readily understood from Fig. 2 which represents a condensed profile of a road.

Let the elevations of the summits be designated by s_1, s_2, s_3, s_4, etc., and the sags by v_1, v_2, v_3, etc. The difference in altitude of the termini is $s_5 - v_1$. The total lift is the sum of the several lifts or

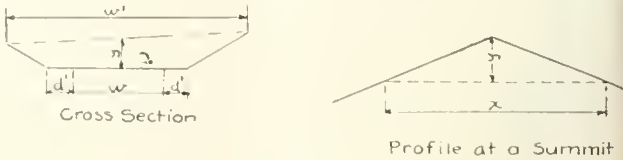
Total lift

$$= (s_1 - v_1) + (s_2 - v_2) + (s_3 - v_3) + (s_4 - v_4) + (s_5 - v_5)$$
$$= s_1 + s_2 + s_3 + s_4 + s_5 - v_1 - v_2 - v_3 - v_4 - v_5$$

From this we may subtract the difference in altitude and obtain the amount of excess lift, thus

$$X_L = s_1 + s_2 + s_3 + s_4 - v_2 - v_3 - v_4 - v_5$$

If a maximum center cut of y feet and a corresponding fill be made at each summit and sag, the excess lift becomes



Cross Section

Profile at a Summit

Fig. 3.

$$X_L = (s_1 - y) + (s_2 - y) + (s_3 - y) + (s_4 - y) - (v_2 + y) - (v_3 + y) - (v_4 + y) - (v_5 + y)$$

This equation reduces to the form of

$$X_L = \underbrace{(s_1+s_2+s_3+s_4)}_{\text{a constant}} - \underbrace{(v_2+v_3+v_4+v_5)}_{\text{a constant}} - 8y = c^1 - 8y$$

For any particular alignment, the elevations of the summits and sags remain fixed, while y may be made to vary until an economic excess lift is obtained for such alignment. In general

$$X_L = c^1 - ny$$

in which n is the number of summits between termini. The economic maximum cut is now readily obtained by solving for y.

$$y = \frac{c^1 - X_L}{n}$$

Upon this value of y, the grading quantities depend, as will be easily seen from Fig. 3.

x varies y, or $x = by$

$$\text{Area of cross section} = \frac{(w + 2d^1 + w^1)y}{2}$$

$$\text{Volume} = \frac{(w + 2d^1 + w^1)y^2b}{4} \text{ at one summit.}$$

By the substitution of equivalents, this reduces to the form of

$$\text{Volume} = \frac{by^2T_a(2S^2_m + v_1)\,(b^1 + S/10)}{5280KHS} + d^1by^2 + \frac{by^2[a(c' + c'') - 2X_L]}{4n}$$

This expression will be needed in arriving at the cost of grading.

The Vehicle Element—The vehicular equipment needed to carry a given tonnage over this roadway will consist of N units, each having a load capacity of K tons. This, of course is not the usual miscellaneous equipment which at present uses any road, but it is the economic equipment which we are seeking to determine.

Let K = capacity in tons of one unit

t = number of round trips per annum per unit

h = the time in hours required for one round trip

H = the total number of working hours per annum

S = average speed in miles per hour

L = length of roadway in miles

T_a = annual tonnage to be transported.

Then the time required to make one round trip is

$$h = \frac{L}{S},$$

while

$$t = \frac{H}{h} = \frac{HS}{L}.$$

Amount of tonnage hauled per annum by one unit is Kt

Amount of tonnage hauled by N units is $T_a = NKt$.

By substitution we have

$$T_a = \frac{NKHS}{L}, \text{ or } N = \frac{T_aL}{KHS}$$

X and K represent the characteristics of the vehicular equipment.

Motive Power Element. The amount of energy required to transport the given tonnage over the road will depend on this tonnage plus weight of vehicles and upon the amount of mechanical work per ton of load [illegible] that has to be done in traversing the road. This [illegible] is that of overcoming the tractive resistance and of lifting the loaded vehicle through a vertical distance. The [illegible] resistance varies with the different types of road surfaces, while the height through which the load must be lifted is dependent upon the difference in altitude between termini, which remains fixed, and upon the [illegible] the grade line. This latter [illegible] adjustment. The total climb that [illegible] the sum of the climbs for each hill between the termini. No advantage results from descending one hill to climb the next. The excess lift, as before stated, is the [illegible] difference in altitude between the termini. [illegible] may be reduced by increasing the cuts at the summits and the fills at the sags of the profile. It [illegible] economic excess lift.

The work done in overcoming this [illegible] and tractive resistance may be expressed in terms of the annual tonnage and the properties of the roadway.

Let V = the work done by one passage of one vehicle

L = length of road $= L_e + X$

z = unit tractive resistance expressed decimally

W_t = weight of loaded vehicle in pounds

D_t = difference in altitude of termini

X = excess lift; then

Total lift $= D_t + X_L$ in feet.

Tractive resistance per load $= zW$

Using the foot-pound as the unit of work we have for one vehicle

$$V = W_t(D + X_L) + 5280(L - X)zW$$

The work done in one year's time would be the product of V by the number of loads hauled. The number of loads required for T_a tons per annum is $\frac{T_a}{K}$. The weight of the loaded truck can be expressed in terms of its capacity by using the data presented in Fig. 5 or the equation

$$W_t = 6000\,K^{[illegible]}$$

The annual work done for all loads is

$$V_a = \frac{VT_a}{K}$$

By substitution, we obtain

$$V_a = \frac{6000T_a}{K^{[illegible]}}\left\{D + X_L + 5280(L_e - X)z\right\}$$

The total motive power must be sufficient to meet this demand plus an additional amount absorbed in friction of engine and transmission gearing. The power [illegible] any vehicle must also be sufficient to prevent stalling on the steepest grade and on the roughest portion of the roadway.

Development of Formulas for Cost of Roadway, Motive Power and Vehicle Elements.—There has now been developed expressions for [illegible] in terms of the properties of these elements and of annual tonnage. It now remains to [illegible] the cost of these elements in terms of [illegible] properties [illegible] determine the cost of [illegible] this is measured [illegible] at the cost per [illegible]. The [illegible] the total annual cost [illegible] annual cost as composed of three major items:

1. Annual cost of roadbed.
2. Annual cost of equipment.
3. Annual cost of power.

In turn these major items [illegible] can be set forth in Table I.

From Table I it is seen that there are [illegible] to be analyzed in order to ascertain what factors affect the total cost. Let us, therefore, consider in succession the salient features of each item and determine the contributing factors. To do this, one factor only will be considered as varying at one time.

TABLE I.—SUMMARY OF COST ITEMS

Annual Cost of Roadbed.	1. Interest on construction cost.	1. Land [illegible] 2. Clearing and grubbing. 3. Grading. 4. Paving. 5. Bridges, culverts, and drains. 6. Fences, signs, [illegible] 7. Engineering and [illegible]
	2. Maintenance.	1. [illegible] 2. Renewals.
	3. Administration.	
	4. Amortization.	
Annual Cost of Equipment.	1. Interest on first cost. 2. Licenses and taxes. 3. Insurance. 4. Administration. 5. Amortization. 6. Maintenance (Repairs and [illegible]). 7. Garaging.	
Annual Cost of Power.	1. Gasoline. 2. Oil, grease and waste. 3. Maintenance of power [illegible] repairs and renewals). 4. Drivers' salaries.	

Total Annual Cost = {Annual Cost of Roadbed} + {Annual Cost of Equipment} + {Annual Cost of Power}

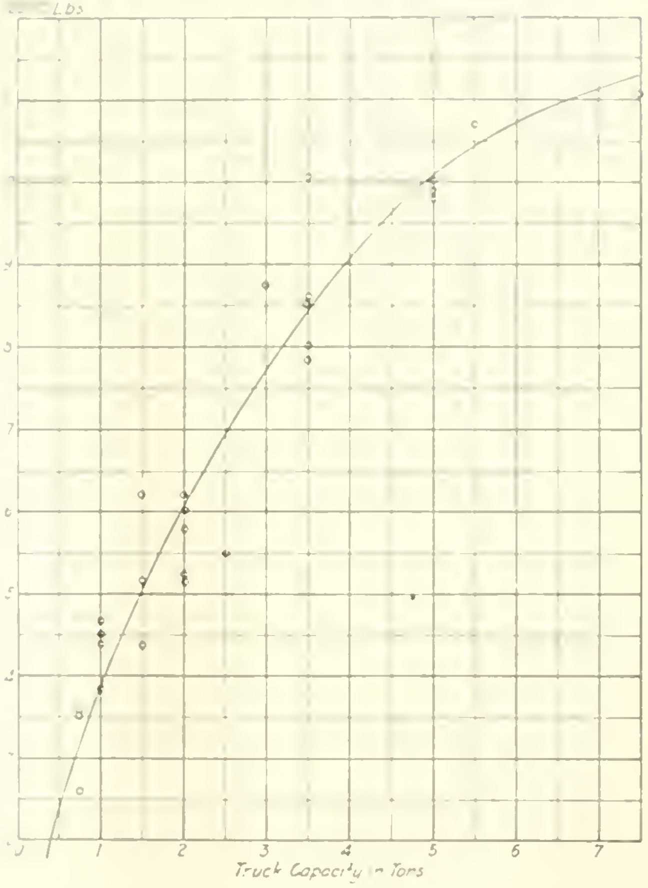


Fig. 4.—Weight of Truck (Chassis and Body).

Annual Cost of Roadbed.

1. Interest on cost of construction: Interest on the cost of construction is readily obtained when the cost becomes known. This cost of construction is the sum of its seven component items. It is influenced by the unit cost of each item and by the number of units, or quantity. For the present we are chiefly concerned with the quantities.

Right of way: Measured in acres. A formula has already been derived for this.

2. Clearing and grubbing: Also measured in acres.

3. Grading: Measured in cubic yards of excavation for which a formula has been developed.

4. Paving: Measured in square yards according to previous formula. However the unit cost of pavement will vary with the type and with its thickness. The thickness is a function of the wheel load, bearing capacity of the subgrade and of the width of pavement. Various authorities have proposed formulas for thickness, but there is needed further investigation of this feature.

5. Bridges and culverts: Other things being equal, this item will vary directly as the wheel load and as the width of pavement.

6. Fences, signs, etc.: This factor varies directly as the length of roadway.

7. Engineering and legal expenses. This item is covered by a percentage charge on the sum of the preceding cost items.

2. Cost of Maintenance: This item depends upon the amount of wear that the traffic produces. This wear varies with the wheel load, the kind of tire, the number of passages of load per annum, the amount of previous wear, the roughness of the pavement, speed of vehicle, impact of unsprung parts of vehicle, and the tractive resistance of pavement. The amount of wear decreases as the resistance of the paving material increases.

Although there are some published data on the cost of maintaining roadways, such cost is stated in time units and is not correlated with the amount and kind of traffic and, therefore, is not in a form available for an economic investigation of the present type. For our purpose, it will be necessary to think of traffic as so many passages per annum of a standard wheel load at a standard speed, or the equivalent of this.

3. Cost of Administration: As the purpose of administration is to carry on effectively the maintenance work, the amount of such maintenance work is reflected in the amount of administrative work. Hence the cost of administration may properly be taken as a percentage of the cost of maintenance.

4. Cost of Amortization. The value of this item will depend on the cost of construction work needing replacement at long time intervals—such part of the roadway that deteriorates in spite of the annual maintenance given the roadbed. It will also depend on the rate of compound interest, and upon the life in years of such construction. As the life of the pavement is to be measured in terms of the number of passages of the standard wheel load, it will be best to convert this into years by dividing the total number of passages, which the pavement will endure, by the number required to transport the given annual tonnage. When this is known, the annuity required to redeem the investment can readily be ascertained.

Annual Cost of Vehicles.

1. Interest on First Cost: The first cost of the vehicular equipment depends on the number of vehicles and the cost per vehicle. This unit cost decreases as the capacity of the truck increases. This relation is set forth in Fig. No. 6. The price shown for any particular size truck is an average of many. In the more usual cases, fifty different makes were considered.

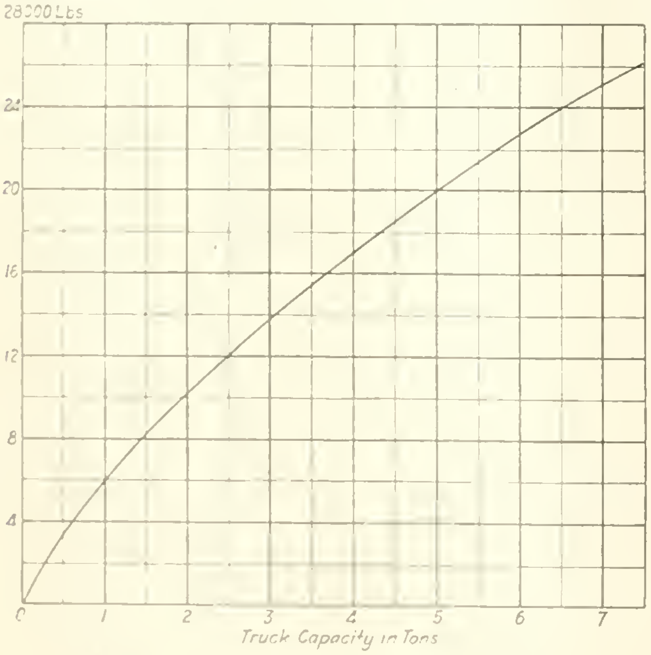


Fig. 5.—Weight of Loaded Truck (W = 6000K [illegible]).

2. License and Taxes: This item is controlled by legislation. However in an equitable scheme of taxation, the amount should be sufficient only to replace the wear caused by the vehicle on the pavement. This amount of wear, as before stated, depends on the wheel load, speed of vehicle, type of pavement, etc.

3. Insurance: This item depends directly on the first cost of equipment.

4. Administration: The cost of administration will vary directly as the number of trucks required and, also, as the work of maintaining the vehicular equipment varies.

5. Amortization: This item depends on the original investment that needs replacing and upon the life of the equipment. The life of the equipment is a function of the amount of mechanical work done per annum.

6. Maintenance: This item depends on the amount of mechanical work done per annum by the vehicle passing over the road. In turn the amount of mechanical work done depends upon the length of the roadway, upon the amount of excess lift, and upon the tractive resistance of the pavement. Observations are needed to determine the life of a vehicle in terms of the work done.

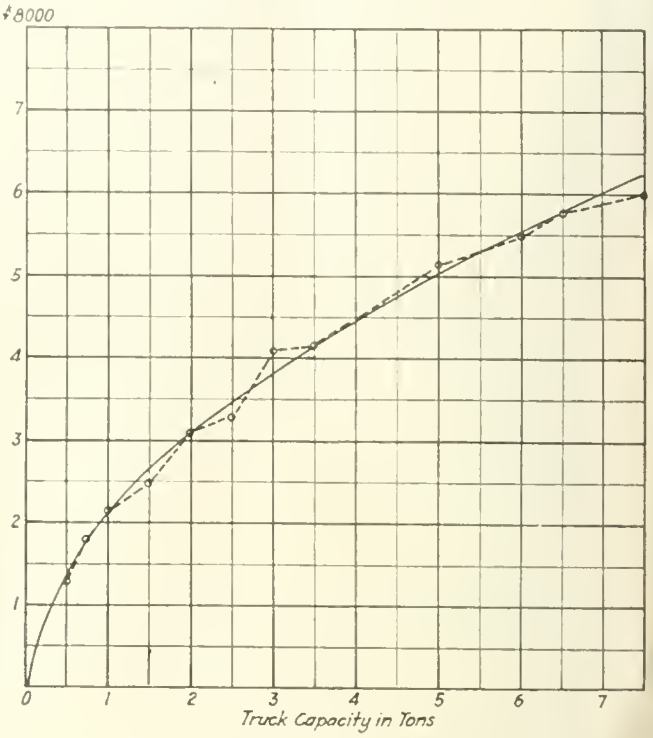


Fig. 6.—Cost of Truck ($C_t = 2100\ K^{0.54}$).

7. Garaging: This cost item is a function of the number of vehicles composing the equipment.

Annual Cost of Power.

1. Gasoline: This cost item bears a direct relation to the amount of mechanical work done per annum, which in turn is a function of the roadway properties, and of the efficiency of the engine.

2. Oil, Grease, and Waste: Likewise this item also bears a direct relation to the amount of mechanical work done per annum.

3. Maintenance of Power Plant: The more work done in traversing the road, the more wear and tear on the engine and transmission gearing; hence there is a direct relation between this cost item and the amount of mechanical work done per annum. Here also observations are needed to determine the life of the power plant in terms of the work done.

4. Drivers' Salaries: This item will depend upon the rate per man and upon the number of trucks making up the equipment.

Contributing Factors Upon Which Total Annual Cost Depends.

Although the foregoing is not an exhaustive analysis, it will serve the purpose of the present article. From it there is gleaned the fact that the contributing factors, upon which the total annual cost depends, are of two kinds—fixed and variable. The fixed factors are basic and are controlled by commercial and physical conditions. They are

1. Annual tonnage.
2. Airline distance between termini.
3. Difference in altitude of termini.
4. Hours of work per annum.
5. Intervening topography.
6. Character of subgrade.

The variable factors are the ones admitting of adjustment. They are:

1 Excess distance due to deviations in the alignment of the roadway from the airline location.
2 Excess lift due to deviations in the grade line from a uniform plane connecting the termini.
3 Equipment including the number and size of hauling units.
4 Maximum cut.
5 Resistance of pavement to wear.
6 Tractive resistance.
7 Speed of vehicles.
8 Efficiency of engine.

To properly adjust these variables in such a manner that a minimum cost of transportation will result, there is needed a set of criteria for guidance. This set of criteria should embrace at least the following:

1 Economic excess distance.
2 Economic excess lift.
3 Economic truck capacity.
4 Economic speed.
5 Economic tractive resistance.
6 Economic wearing resistance.
7 Economic width of roadway.
8 Economic cut which will determine the width of right of way.

These criteria are to be expressed in terms of some tonnage, air line distance, difference of altitude, intervening topography, condition of subgrade, and items of other permanent nature.

Quantitative Relation Between Cost Items and Variable Factors.

This brings us to the third step in our program for procedure. It is now necessary to determine the quantitative relation between each cost item and the several independent variable factors. These relations are best set forth in the form of equations. From Table I, it is seen that fifteen equations are required to express the cost in terms of the fourteen contributing factors. When these equations are developed, the total annual cost may be obtained by the simple process of adding the equations. The well known method of partial differentiation will enable us to ascertain successively the effect that each variable factor has on the total cost and also what value of the variable will make the total cost a minimum with respect to such variable. Such value will be expressed in terms of the several contributing factors and so constitutes the criterion we are seeking for the selected variable.

We have now defined the lines along which the development of an economic theory must proceed. It is next in order to note how far our present data will allow us to carry such development. For this purpose we may well revert to the preceding analysis of cost items and summarize the conclusions there drawn.

Further Information Needed Regarding Maintenance.

It is seen that further information is needed principally along the lines of maintenance—maintenance of roadbed as related to traffic measured in standard wheel loads, maintenance of vehicular equipment as related to the amount of mechanical work done in traversing the road, and maintenance of power plant as related to the total amount of mechanical work. There is also needed more investigation of the relation between thickness of pavement and wheel load, subgrade bearing capacity, and width of pavement. The relation between the wear on tires and the type and condition of pavement is also to be included under the head of maintenance data needed.

Some attention has already been given to the cost of maintaining the roadbed, and in some cases the amount of traffic in terms of vehicles per annum has been noted, but what is really necessary is a more precise measurement of traffic density before the cost can be properly correlated with wear. The writer suggests as a unit the passage of one standard wheel load per minute at a standard speed—say a 1,000 lb. load moving at the rate of [illegible] miles per hour. Then the amount of wear produced by this load operating with different kinds of tires should be ascertained. Also there should be an investigation of the relation between other wheel loads and speeds to the aforesaid standard load and the wear it produces on the pavement.

In conclusion, it may be well to emphasize the fact that seven of the fifteen cost equations are dependent upon maintenance data of one kind or another. These [illegible] can not be formulated until the [illegible] have been collected by trained observers having a [illegible] of the goal to be attained. The [illegible] cost equations can be written now with a tolerable degree of certainty, but by themselves would avail little in getting to the next step in the program of procedure. Hence the development of our much needed economic theory is awaiting the working out and the execution of a research program.

Camp Sanitation for Road Construction Camps

Camp sanitation from the standpoint of the relatively small camp such as might be maintained by the average road contractor was discussed by Mr. John N. Edy, Chief Engineer of the State Highway Commission of Montana, in a paper presented at the recent annual meeting of the Montana Public Health Association. An abstract of his paper follows:

That the camp is usually but a temporary domicile does not in the least lessen the necessity and desirability for the application of the recognized principles of sanitation. It does, however, intensify the problem in that the plan of sanitation must be reasonably inexpensive as well as sufficiently effective. Considering this phase of the subject hurriedly we may assume that in a comfortable and sanitary camp there must be:

1 Good, wholesome food.
2 Palatable and safe drinking water.
3 Clean and comfortable sleeping, dining and lounging quarters.
4 Prompt and continuous disposal of kitchen wastes.
5 Adequate and comfortable toilet facilities, including bath accommodation.
6 Proper segregation of all stables and outbuildings.
7 Reasonable fire protection.
8 First Aid service.

Other desirable features might be suggested, but these seem to represent or include practically all the essentials.

Fundamentally, men who work must eat. And if they are to work well and usefully they must eat substantial, well cooked food, served in a clean, appetizing manner. This means a careful selection of foods; a thoughtful composition of menus and the most careful preparation and appetizing service of the meal by competent persons of cleanly habits and appearance. It means that during summer months the kitchen and dining room (or tents) must be screened because flies must be excluded. (I prefer the exclusion of flies to entrapping them on fly paper or in small pans filled with fly poison. Even if a dead fly is harmless, a sticky mass of dead flies can hardly be said to be "appetizing".) Our first requirement means also that uncooked food will be properly stored, always free from contamination due to any cause whatever, including our two camp enemies, flies and rats. "Good, wholesome food," then, means, in substance, that those persons attached to the camp will be permitted to enjoy their meals as well as to be nourished and sustained by them.

Of course water may be either safe and not palatable or palatable and not safe, and the latter is not infrequently the case. The water supply would seem to be the most potential source of danger and should be adequately protected from contamination. While perhaps the ordinary mountain stream represents a safe supply, there is no assurance that such is the case. Certainly water from the ordinary irrigation canal should be viewed with suspicion. As a matter of fact, it would seem to be but sensible and the exercise of every-day caution to have the water examined and tested by a competent person before approving its use. And then, as above suggested, the source of supply should be policed or otherwise insured and safeguarded. Water taken from a creek or river should be procured well up-stream from the main camp, and the immediate vicinity not used for any other purpose. If conditions justify, the water may be boiled or otherwise treated to increase its degree of purity.

But men do not live by food and drink alone. They—and especially is this true of men who do hard manual work—must have restful beds and comfortable lounging and recreation quarters. It is not necessary that a "bunk house" be dolled up like the bridal suite of a metropolitan hotel. It is necessary, however, that the quarters be clean, cheerful, ample in size, well ventilated, well lighted, well heated when necessary, and equipped with clean and comfortable cots, bunks or beds provided with sufficient clean bedding. One would think it altogether unnecessary to refer to this feature of the camp; and yet in this state and in all states are altogether too many examples of the unsanitary, unhealthful and uncomfortable camp sleeping quarters. The bunk house should be cleaned regularly and the bedding aired and washed. In a camp of any size a camp tender should be provided. If screens add to the comfort of the men, they should be provided. And I have in mind one accommodation that is very rarely provided I refer to the construction of cheap gravel, cinder or plank walks that permit the men to pass to and from the several camp units without tracking dirt, mud and filth into the quarters

All kitchen wastes should be deposited in covered garbage cans and removed and disposed of sufficiently far from the camp area. Cheap incinerators may be provided for burning the refuse, or it may be buried. I have spent some time in and about construction camps and have never been quite convinced of the necessity or desirability of maintaining a hog ranch as a means of camp garbage disposal. I regard it as unfortunate but it seems to be none the less true that most camp cooks either own or very speedily acquire one or more squealing pigs which they proceed to develop on camp "slop" in the most approved southern negro fashion. If a pig sty must go with the camp it should be located not closer than the adjoining county.

Camp facilities for receiving and disposing of bodily wastes are usually crude and unsanitary when very little additional expense would provide proper and safe accommodations. The danger here is from flies and the contamination of drinking water. A reasonable care and thought in laying out the camp site will permit an arrangement of outbuildings that will be both safe and sanitary. Disinfectants should be used freely and frequently and the exterior premises maintained in a neat and clean condition.

Most men desire to bathe, but those who are not so inclined should be required to observe the usual rules of bodily cleanliness. Bathing accommodations must be provided and used.

Needless to say, stables and similar units should be properly segregated and cleaned. Stable waste must not be permitted to accumulate, but must be removed regularly.

Reasonable fire protection may be provided in several ways, one of which involves the erection of a modest and inexpensive water tank that may be filled by pumping and with which is a sufficient length of hose to reach the principal units of the camp. Fire protection may not be thought to be an essential of sanitation. But the tank and hose may be used to advantage for laying the dust by sprinkling.

First Aid service is essential, particularly in camps far removed from medical practitioners. In large camps a physician may be retained to make frequent physical examinations of the men, and to advise in matters of general sanitation.

Nothing has been said of laundry facilities, although it would seem that this matter is important and must certainly have the attention of the camp proprietor

And now, briefly, what of camp regulations? Simply this: that as long as men are human they will at times become careless. Few men are naturally or habitually unclean; but many men are thoughtless and not a few are ignorant of the most elementary health rules. A camp can be kept sanitary only by the most rigid enforcement of regulations covering the requirements of the case. Typewritten copies of these regulations should be placed conspicuously in every unit of the camp and as new men enter the camp they should be informed as to the text and significance of the sanitary regulations. Experienced and wise contractors will discharge an employe more readily for violating the camp rules of sanitation and conduct than for failing to perform the manual tasks assigned him

Florida State Road Department Favors $20,000,000 Bond Issue. The state road department of Florida at its annual meeting July 9 passed a resolution endorsing the proposed amendment to the state constitution, to be voted on at the November general election to allow the state to bond for not exceeding $20,000,000 for state highways The department endorsed the proposal that the interest and sinking fund of said proposed bond issue be met by a tax on motor-driven vehicles.

Motor Vehicle Registrations, Licenses and Revenues in 1919

A total of 7,565,446 motor cars, including commercial vehicles, and 241,038 motor cycles were registered in 1919 in the United States. The registration and license fees, including those for chauffeurs, operators, and dealers, amounted to $64,697,255. Interesting information on motor car registrations, and revenues is given by Andrew P. Anderson, Highway Engineer, Bureau of Public Roads, in a recent publication of the Bureau. According to this, the data for 1919, as compared with 1918, represent an increase of 23 per cent, or 1,418,829 motor cars. This increase alone represents about 10 per cent more cars than the total number registered in the United States during the calendar year 1913. In this connection it is interesting to note that the number of cars registered during 1919 in the two States of New York and Pennsylvania exceeded the total number of cars registered in the entire United States in 1912, while the revenues derived from the New York and Pennsylvania registrations during 1919 were about double those derived from all motor vehicle registrations and licenses in the entire United States in 1912. The revenues derived from all registrations and licenses during the year 1919 exceed those of 1918 by 20 per cent, or a total of $13,219,838.97. In 1914 the total gross revenues collected amounted to only $12,381,951.

The increase in motor-car registrations and revenues in the United States during the past dozen years presents many interesting comparisons. This is especially true in respect to the use made of the revenues. In 1906 the total registrations were approximately 48,000 cars, paying a gross revenue of about $193,000, or slightly more than that collected during 1919 by the state of Arizona. Furthermore, in 1906 the gross registration revenues were equivalent to less than three-tenths of 1 per cent of the total rural road and bridge expenditures for that year. In 1919 the motor-vehicle revenue represented approximately 16 per cent of the total road and bridge expenditures for the year. Furthermore, while in 1906 practically none of the motor-vehicle revenues were applied to road maintenance and construction, in 1919 over 92 per cent of the gross returns, or $59,907,136.18, were devoted to this purpose, and of the total amount applied to road work, 70 per cent, or $42,192,601.17, was expended more or less directly under the control or supervision of the state highway departments. The remaining 8 per cent not applied to road work was expended very largely for number plates and in carrying out the provisions of the motor vehicle registration laws of the several states.

The approximate relations and rates of variation of the three factors, total rural road and bridge expenditures, motor vehicle registration and license revenues and number of motor car registrations from 1903 to 1919, inclusive, are shown graphically in Fig. 1.

On Jan. 1, 1920, every state but Minnesota had made provision for some definite form of annual state registration. In Minnesota the registrations are for a period of three years, beginning Jan. 1, 1918. Consequently only new cars will be registered and pay a fee during 1920; the registrations made during 1918 and 1919 being effective until the close of 1920.

Use of Motor Tax for Road Work.—Prior to 1912 only a very small portion of the motor vehicle revenues were devoted to road work under the state highways departments, while in 1919, 66 per cent of the total motor vehicle revenues, or $42,192,601, were applied to road work under the direct supervision of the state highway departments. The remainder of $17,714,532 was expended for road work by counties or other local subdivisions with little or no direct supervision from the state highway departments.

In most states the motor vehicle revenues are devoted to the maintenance and repair of the state roads or other improved highways. These states thus seem to have solved fairly well the difficult problem of securing funds for the maintenance of the more important roads under the ever-increasing traffic requirements. As both the traffic and the revenues increase with the number of cars, there exists a possibility of so adjusting the registration rates as to keep pace with the ever-growing maintenance charges.

A number of states having but a small mileage of improved roads have recently adopted the plan of capitalizing the motor vehicle revenues and devoting these funds to road construction. These states are Alabama, [illegible] Maine, Minnesota, Nevada, and Utah. In these states bonds have been issued for road construction the interest and principal of which are to be paid entirely from the motor vehicle revenues. There seems to be no doubt that these revenues will prove sufficient for this purpose. The question which remains to be solved in these states is whether such revenues will yield sufficient maintenance revenue to prevent the deterioration of the roads constructed from these bond issues.

The total road mileage in the United States, outside of incorporated towns and cities, is about [illegible] miles. With a total registration of 7,567,116 motor cars there was, there-

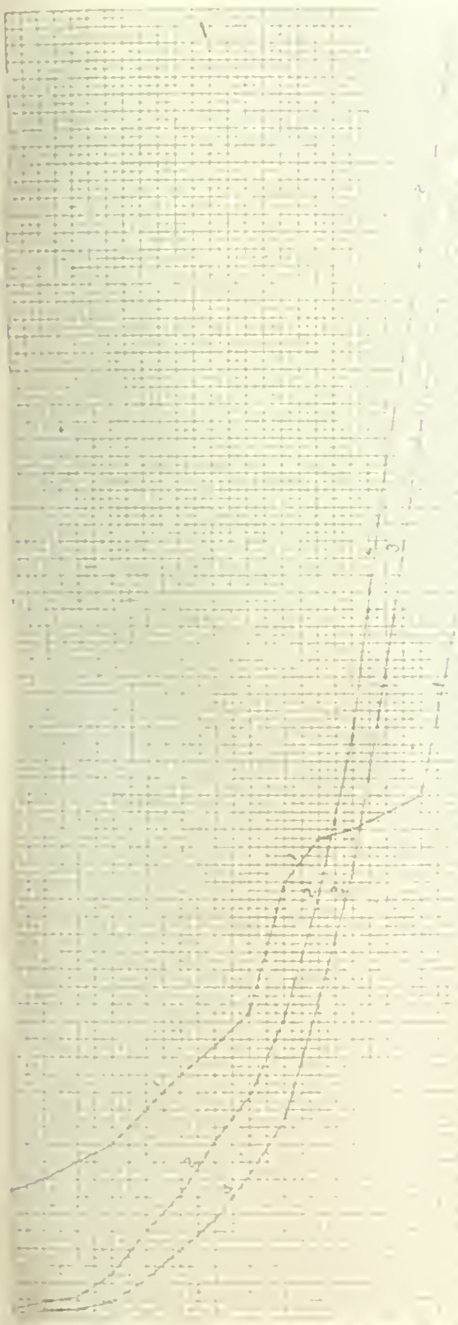


Fig. 1—Relations of Total Rural Road and Bridge Expenditures, Motor Vehicle Registration and License Revenues from 1903 to 1919, Inclusive

fore, an average of 3 motor cars for every mile of public roads in the United States. The distribution of cars in the United States, however, is far from uniform. Thus New Mexico and Nevada have less than 1 car per mile of road while Rhode Island has 21 cars, Massachusetts and New Jersey 15, and California 8 cars per mile. Furthermore, while there was an average of 1 motor car for every 14 people in the United States, in the state of Iowa there was 1 motor car for every 6 persons, in California, Nebraska, and South Dakota 1 for every [illegible], and 1 for every [illegible] in Kansas, but only 1 car for every 41 persons in Alabama, [illegible] in [illegible], [illegible] in Arkansas, and 29 in Tennessee and West Virginia.

Fees for Motor Trucks.—At the beginning of 1919 there were still 12 states in which motor trucks were registered at the same rate as passenger cars. The past year or two, however, have shown a very decided tendency toward increasing the fees required for heavy motor trucks over and above those required for passenger cars. This increase is usually based on the weight of the truck, its carrying capacity, its horsepower, or a combination of these factors. The more general practice seems to be toward definitely limiting the maximum total weight of the loaded vehicle and basing the registration fee on the carrying capacity of the truck.

A few states specify no maximum load limit but prescribe a rapidly increasing rate per ton of load so as to discourage effectively the use of extremely heavy trucks. A number of states have also provided legislation to limit the maximum wheel load per inch of tire. It is unfortunate that the term motor truck and commercial vehicle is as yet rather indefinitely defined in the laws of a number of the states. In a few states no distinction is made between passenger and freight carrying cars, while in one state only trucks used for hire are classed as commercial vehicles.

The amount of fees collected per car for either pleasure or commercial vehicles is as yet far from uniform, and is still further complicated by the widely varying requirements for the registration or licensing of chauffeurs, owners, operators, dealers, etc. Thus, if the total gross registration and license receipts be used as a basis of revenue, and the total automobiles, trucks, and commercial vehicles as the basis for measurement, it is found that for the entire United States the average fee per car for 1919 was $8.74. On the same basis the state of West Virginia received $[illegible] per car, New Hampshire, $18.96, Maryland, $18.47, and Vermont, $17.17, while the state of Minnesota received only an average of $1.[illegible] for each car registered within its borders, as in that state the registration is for a 3-year period, the first year of which was 1918.

The states of Colorado, New Mexico, and Oregon devised an additional method of securing road revenues by levying a state tax on gasoline or other products used for the propulsion of motor vehicles. In Alabama, Delaware, Idaho, Iowa, Michigan, New York, North Dakota, Oklahoma, South Carolina, Pennsylvania, and Vermont the registration fees are in lieu of all other taxes. In other states, however, motor cars are taxed as personal property in addition to the required registration fees.

Lifting the Other Man's Burdens.—I want to leave with you a thought I had at Baldwin's Locomotive Works. I was going through that great institution one day and suddenly in all that din and noise and that apparent confusion, which has system disguised, fancy hid me. I read on the side of a locomotive the name of a railroad in India. In a minute I was back 20 years. I was transported in fancy over 15,000 miles and to the hottest day I had ever witnessed in my life. Looking down the road once more I saw a road as white as this table cloth now before me. As I watched that road I saw down the center a line of little black dots. I had been studying conditions in the neighborhood and I knew that each one of those dots was a native bent nearly double, carrying a burden twice as heavy as God intended him to carry. I knew that every one of those men was chewing a betel nut steeped in lime to deaden the pain of mere life. I saw that picture again. Then I looked at that locomotive in Philadelphia, and I said, "There is power when put on the rails in India to lift 20,000 burdens from 20,000 of such children of the living God, giving them the first chance to see their Father's face." There is not an action of an honest man that does not somehow, under the Providence of God, lift some other man's burden—that does not broaden some other man's life.—Dr. Edward J. Cattell in address before Engineers' Club of Philadelphia.

Meeting of Michigan Road Commissioners.—The annual meeting of the road commissioners of Michigan will be held at Prudden Auditorium, Lansing, Mich., Sept. 1, 2 and 3. W. M. Bryant, 206 Woodward Avenue, Kalamazoo, Mich., Field Secretary.

Methods and Cost of Constructing and Maintaining Shell Roads*

By J. M. HOWE.
Of Howe & Wise, Civil Engineers, Houston, Tex.

For about 15 years the writer has been handling shell as a road material. He has seen the much lauded shell roads of 10 years ago practically disappear under present day traffic. He is satisfied that as a material for the wearing surface of main traveled highways shell is not a suitable nor economical material, but as shell is practically the only road material indigenous to the Texas Gulf Coastal Plain it should not be unqualifiedly condemned. A well finished shell road gives a surface smoother than asphalt and under light traffic, this surface can be satisfactorily maintained, but under heavy traffic the maintenance becomes prohibitive.

The Various Kinds of Shell. Before going into detail it may be well to dispel an apparent misunderstanding as to what "shell" is. Generically, the unmodified noun covers several classes of material which differ greatly in road building qualities and in the methods of placing.

Probably the best, and certainly the scarcest are the oyster shells from oyster "shuckeries" and canneries. These are fresh "live" shell, hard and tough, that when consolidated into a road surface will stand up under fairly heavy traffic. The method of using them was developed by the Maryland State Highway Department and is well covered by the Texas State Highway specifications.

Next in importance are the clam shells, which are found in banks on the shores of interior bays and estuaries. These bank deposits are usually too limited in quantity to justify the installation of mechanical handling devices so that their use is limited to construction within motor truck hauling distance. Dredging operations near the shores of some of the shallow bays have developed the fact that there are large quantities of clam shell that can be made available by this method. So far dredging of clam shell as an industry has not been resorted to, but it can not be long before something is done along this line.

Clam shell being very hard and fairly tough make a good road material. The famous shell roads around New Orleans are of clam shell. As they come from the bank they usually carry some filler material. If filler material is lacking, it must, of course, be supplied. Rolling is advantageous, but practically as good results can be obtained by continuous dressing with a grading machine until the road has set up.

The Reef Shell Road.—The great bulk of the shell road construction is done with reef shell. This is broken up partially decayed oyster shell found in reefs in the coastal bays. It varies in quality in different reefs and even in different parts of the same reef. In places in the reef it is mixed with considerable sand and blue mud. In the early days of the industry the shell was excavated with a dipper dredge and a considerable content of mud accompanied the shell. In fact, experienced road builders preferred to use it at about the consistency of quaky concrete. Careless dredging, with consequent excess mud brought about specifications limiting the mud and sand to not more than 30 per cent.

The suction dredge supplanted the dipper dredge and not only produced a product that complied with this requirement, but produced it more economically. The suction dredge, however, introduced a new trouble—it made the shell too clean. No binder is nearly as bad as too much. Attempts to hold part of the filler in the shell by regulating the overflow gates on the barges so as to give a longer settlement period produced a sand instead of a clay filler. This formed in pockets and proved very detrimental. Possibly the dredging companies can better this condition, but as the demand exceeds the present rate of production there is not much chance of their doing anything for the present.

Method of Building Reef Shell Roads.—The method of building reef shell roads seems exceedingly primitive. The shell is dumped from wagons and spread with shovels or hoe. Spreading with a grading machine is unsatisfactory as it makes a lumpy road. Rolling is useless, as the particles of shell are flat or nearly so and break up under the roller instead of wedging and compacting. Accepted practice is working with a blade grader daily for 10 days or two weeks and then, as required, to keep ruts filled until the road sets up. The time required to accomplish this depends upon the traffic and weather conditions. After a shell road has once set up the wear takes the form of pot holes and cross ridging or wash-boarding.

Repair work, when taken in time, can be done with a blade grader operated during or immediately after a rain. Patching small holes with the kind of material that is being furnished now is not very satisfactory. The shell is too clean and will not stay in the holes. Deep holes can be filled with more success. The material is very soft and wear rapidly, forming quantities of fine white dust and requiring frequent resurfacing when the traffic is heavy.

Mat Surface Work in Reef Shell Road.—Appreciating the weakness of the wearing surface much experimenting was done to try to strengthen it. Harrowing washed or nearly clean gravel, 1 in. and smaller, into the surface has helped materially and is now an accepted form of construction. Efforts to toughen the shell by penetration applications of asphalt, and by harrowing the asphalt into the surface of the shell and then rolling were unsuccessful as were also the first attempts at mat surface applications. Perseverance in experimenting on the mat surface work has finally developed methods that are reasonably successful. Both one coat and two coat work are being used. In the two coat work, the first application of light oil is 0.3 gal., followed after a short period for setting up by 0.3 gal. of heavy oil. With one coat work 0.5 to 0.6 gal. of heavy oil is applied.

Owing to the fineness of the shell dust particles and the possibility of dust pockets in the surface it is very essential that the sweeping and cleansing of the surface be thoroughly done. A clean surface is even more important on shell than on gravel, as there are less projecting surfaces to which the bitumen can adhere.

The cover material is important. Best results have been obtained from trap rock passing a 1-in. screen and retained on a ¼-in. screen. Larger sizes of stone were tried but were not as satisfactory owing to inability to get the voids filled. Graded gravel from ¾-in. down does fairly well and limestone, put on a year ago, has up to date given good results. Sand as a cover was unsatisfactory.

Retreatment is necessary in from 12 to 18 months on tar-treated roads, owing to the loss of elasticity of surface material. Where asphalt is used frequency of retreatment is more nearly proportional to the traffic ranging from 12 months to 3 years.

Surface Treatment Success Under Light Traffic.—An unfortunate feature of treatments has been the unexplained lack of uniformity in results where apparently identical conditions prevailed. Careful study of the failures may give information that will prevent them in the future. Apparently surface treating can be done successfully on shell roads carrying traffic of 500 or 600 vehicles per day, provided there is not too much heavy truck traffic, but it is absolutely essential that there be a compact heavy base. No surface treatment is any better than the base that carries it and most of the failures can be traced to movements and settlements, even though these settlements are imperceptible from casual examinations of the surface. With the loads that the present-day roads are expected to carry it is absolutely necessary to increase the thickness of the shell so as to spread the load on the subgrade. No definite thickness can be specified as it should be controlled by the character of the soil. Where thicker bases are used it would be well to put the shell down in at least two layers, letting the traffic compact the first layer before the second one is put on. Shell shrinks from 20 to 25 per cent when put on the road, so that to get a 12-in. thickness it would require 15 in. of loose material. This depth can not be fully compacted in one layer.

Cost of Maintenance and Surface Treatment.—The cost of maintenance of untreated shell roads carrying about 600 vehicles per day was last year $2,000 per mile. With increasing costs this price will be at least $2,500 per mile this year.

Surface treatment at present prices costs 40 ct. per square yard or $3,300 per mile for a 14-ft. roadway. Repairs for four years should cost no more than $500 per mile per year. This, with an intermediate retreatment at $2,700 per mile will make the four years' cost of the road $8,000 or $2,000 per mile per year. The surface treated road should carry a traffic of 100 vehicles per day [illegible] the above costs, therefore it would appear [illegible] to surface treat shell when the maintenance cost exceeds $[illegible] per mile not only because it is a good investment but on account of the better maintained surface and relief from the dust nuisance.

---

*Paper presented June 21 before the Texas Road and Building Association.

Cleaning Road Surface With Compressed Air

By W. A. W[illegible]

[illegible] Manager and Chief Engineer [illegible] Interstate Park, Haverstraw, N. Y.

An interesting experiment has [illegible] putting a new wearing coat on the main [illegible] Interstate Park.

This drive, extending from B[illegible] Hudson River back through the center [illegible] of the Palisades Park to Tuxedo [illegible] opened for traffic [illegible] years ago. It has been [illegible] heavy [illegible] cars, automobile trucks and [illegible] trailers—and nothing has been done [illegible] surface since it was opened.

It is a bituminous macadam road [illegible] three layers on 1[illegible] in. of hand placed telford. The [illegible] granite, both in the telford and macadam, was crushed and quarried along the line of the road. One and a half [illegible] stone was spread and rolled to 2-in. thickness on top of the telford and [illegible]

Compressed Air Outfit Blowing Dust from Road Preparatory to Putting on New Wearing Surface.

this 1 gal. per square yard of Standard Oil binder B was poured by hand pots. A second layer of stone, the same size and thickness as the first, was immediately spread and rolled into the first and a similar application of 1 gal. of Binder B per square yard was applied to this second layer and over this was spread, immediately, a 1-in. layer of ¾-in. stone which was at once thoroughly rolled in. An application of ¾ gal. per square yard of the Binder B was then made and covered with enough screenings to enable a roller to work.

Traffic was admitted at once to the road upon its completion and it has been used both summer and winter by very heavy traffic and nothing has been done to the surface until this spring.

There were no pockets and no [illegible] of ravelling in the road, but its surface had worn down until it showed throughout its entire length, all of the ¾-in. stone. This stone had worn slightly and the entire surface was much like that of a grindstone. It was decided to put a wearing coat on this road this spring and in order to secure a proper bond for this coat, the road was swept with wire brooms. A small portable air compressor, of 75 cu. ft. capacity, was equipped with two hose fitted with very small aperture nozzles and this compressor was hauled over the road behind the sweepers and all of the dust blown from the surface. This equipment, which required the services of three men, covered about ½ mile of the road per day and removed all of the dust from the road surface. When the seal coat of the Binder B was applied with a truck and under pressure it bound itself absolutely to the road surface. This truck was followed by a crew of men who spread screenings of the same stone to a depth of about ¼ in. and these screenings were rolled in [illegible] roller. This binder was applied ½ gal. per square yard at a temperature of 300°. The weather was very hot while the work was being done. The screenings were pressed into the binder and there was very little bleeding after the road was opened for traffic.

Where this bleeding showed the screenings were swept back over it and after the road had been opened for about a week, the fast moving cars had blown most of the remaining screenings to the shoulders.

A careful examination shows that there is practically a perfect bond between this seal coat and the original coat and it has made a splendid wearing surface.

It is difficult to give the exact cost of the application of this coat for the following reasons: The distribution of the screenings along the road was done by motor trucks. They were dumped at intervals of 50 ft. and the piles staggered so that the shovelers would have no difficulty in covering rapidly the whole surface. The cost of the distribution of these screenings was much greater in some sections of the road than others on account of the length of haul, but it averaged about $1.10 per cubic yard. Eight men with wire brooms swept about ½ mile per day of the road. The compressed air machine with its crew covered about ½ mile per day. The Binder B was heated in tank cars at one end of the road and the trucks were only able to make two trips per day at points beyond a 5-mile haul, three trips per day at points beyond a 3-mile haul, and four and five trips on the shorter haul. Each of these trips covered about [illegible] ft. of surface. Sixteen men were required to shovel the screenings onto the road and these men were, of course, only engaged in actually shoveling screenings about two hours of the day on the extreme hauls. They were used on the job in fixing up parapets, gutters, and in forestry work while not actually engaged in spreading the screenings. The steam roller was likewise idle a great part of its time on the long hauls. It was necessary to open the road each Saturday and Sunday while this work was being done and this necessitated the re-sweeping and blowing of ½ mile each Monday. On three occasions, the delivery of the Binder B by the railway companieswas held up and necessitated lay-offs of the entire crew for one or more days at a time. Accidents to the motor trucks used to spread the oil necessitated three delays of one or more days. Rainy weather, in which no work was permitted to be done, also caused three delays.

The delays and hold-ups attributable to the above causes brought the cost on this job up to $1,106 per mile.

Had it been possible to put more oil trucks on the job, another compressor, and so cover the road at the rate of 1 mile per day, the cost of this job would have been as follows:

[illegible] Cu. yds. of screenings at $1.1[illegible] per cubic yard	$[illegible].30
[illegible] Gal. Binder B at 1[illegible].65 ct. per gallon	586.63
[illegible] Air compressors with crews, $20 each	40.00
1 Steam roller at $20	20.00
6 Sweepers at $3.00	18.00
6 Shovelers at $3.00	18.00
1 Foreman at $5.00	5.00
Total cost per mile	$816.93

Convict Labor on Road Work in Nebraska. Nebraska is using convict labor on road projects in three counties, Johnson, Seward and Pawnee, according to the Service Bulletin of the Iowa Highway Commission. The determination to use convicts was made after the rejection of all bids on federal and state aid projects in these counties because of excessive high prices on earth excavation. The state expects to be able to do the work at the estimated prices. There will be four camps, each camp having 18 men, a cook and two supervisors. Prisoners will work 10 hours per day but not on Sundays. Each prisoner will receive $1.50 per day with board, while the state institution will receive 75 ct. per day per man. The institution will receive $1.50 per week per man and each man will be credited with $9 per week from the state for the 60 hours' work or at the rate of 15 ct. per hour. The convict garb has been discarded.

7,500,000 Cu. Yd. of Dirt Moving on Nebraska Road Jobs. Preliminary estimate of contracts let by the Nebraska State Highway Department for Federal aid road projects call for 7,[illegible] cu. yd. earth excavation.

Michigan Maintenance Methods for Gravel and Broken Stone Roads

In a paper presented at the last annual Short Course in Highway Engineering at the University of Michigan, Mr. G. C. Dillman, Maintenance Engineer of the Michigan State Highway Department, described the methods that had been found successful in his state in maintaining gravel and broken stone roads. The notes following are abstracted from his paper.

Gravel Road Maintenance.—The kind and extent of maintenance of gravel roads depends somewhat on traffic conditions and future development. While the maintenance of a gravel road is comparatively simple, so far as methods and general knowledge of the materials is concerned, yet it is one of the improved types of road which is so commonly neglected. The old adage, "familiarity breeds contempt," surely can be applied here. Of course there is a limit to what traffic a gravel road can be subjected to and still be maintained economically, but when that limit has been reached our problem then becomes one of reconstruction or building a more permanent type.

The proper time to begin work on a gravel road is early in the spring just as the frost comes out of the ground. At this time the surface is somewhat loosened from the frost action and it is possible to move the old material with more ease than at any other time during the season. Some gravel is usually thrown out by traffic and this should be drawn in towards the center of the road to fill ruts and low places. All oversize stone projecting through should be removed before adding new material because they invariably work to the surface and make it rough.

When possible new material should be added during the early season as at this time it will bond much easier. An attempt should be made to replace each year as much gravel as is worn off. Do not put too much, however, at any one time. A light course will not interfere with traffic and a smooth uniform surface will be had by frequent dragging until the gravel is compacted.

Care should be taken in selecting the repair gravel as best results are obtained when it is of the same quality as that already in place. This will result in a more uniform surface which is very desirable.

Gravel that is used should not exceed 1 in. in size for heavy traffic roads. For roads having a light traffic the size may be increased such that all material will pass a 1½-in. circular opening. If it is impractical to screen the gravel as is generally the case in winter hauling the oversize stone may be spiked out and removed from the road.

All depressions and shallow ruts should be kept filled. This is most economically done by shoveling the gravel from the patrolman's truck, wagon or wheelbarrow into the depressions. Take advantage of rains as the depressions are then most readily observed and the water will aid the new gravel in bonding onto the old surface and in its compacting under traffic.

New material should be available along the roadside when the road is patroled. Stocking space should be provided for if such was not done when the road was constructed. Whenever possible make use of convenient places outside the ditch lines. In this way the piles will not interfere with traffic and will not obstruct the drainage system.

Take advantage of rains and keep the surface smooth and uniform by systematic dragging. If this is not done regularly or if the surface has become hard it may be necessary to use the heavier road grader or planer. However, for efficient work the gravel road must be dragged regularly. Whether that be done once each week or every day will depend on traffic demands. In any case do not disturb the old gravel bed any more than is necessary to maintain the proper shape and crown.

In some sections of the state and in all, at times, teams are not available for this work. A 2 or 3-ton truck or a light tractor will pull one or two road planers, a light grader or a three-way drag and do satisfactory work. More motive power must be used but to get as good results as with teams, operators should be frequently cautioned to use more judgment and less speed.

Calcium Chloride Treatment on Gravel Roads.—Excellent results have been had from the use of calcium chloride as a dust preventive on gravel roads. The use of this material has been somewhat limited due to the fact that it has been hard to get until recently. Specifications have been prepared for the Michigan State Highway Department from which the following is quoted:

"The material shall be in the form of loose dry lumps or flakes free from dust and fine enough to feed readily through the common forms of spreaders used in road work. The calcium chloride shall be delivered in tight steel drums about 21 in. in diameter and 32 to 34 in. high. The name of the manufacturer, the lot number, and the percentage of calcium chloride guaranteed by the manufacturers shall be plainly marked on the drum."

To obtain the best results the road surface to be treated should be in good shape at the time the material is applied. That is, the road should have been dragged thoroughly, having the surface smooth and of proper cross section. The material may be spread with shovels but it is not advisable if a considerable mileage is to be covered. A regular distributor or drill should be used as it not only speeds up the work but a uniform distribution is insured. The latter is very important.

For the first application about 1 to 1½ lb. of calcium chloride per surface yard should be used. This will ordinarily be followed later in the season by a second treatment from ½ to 1 lb. per surface yard. The number of treatments and amount used during the season will depend upon the nature of the gravel and the kind and intensity of traffic. For the best results apply the material after a rain as the chloride will readily dissolve and better penetration can be had.

Workmen should be provided with rubber boots and gloves other than leather when handling this material. The chloride will practically destroy leather and the hands will become sore when in contact with it.

A proper application of calcium chloride will render a gravel road practically dustless and it acts as a binder. Another good result from the use of this material is that the treated surface is more easily maintained by dragging.

The cost of calcium chloride treatment of gravel roads is reasonable. This varies from 2½ to 3 ct. per square yard of surface treated.

Maintenance of Macadam Roads.—Until the automobile became such a factor as a means of transportation the waterbound macadam road proved both economical and fairly satisfactory. The present automobile and heavy truck traffic combined with the steel tire vehicular traffic has proved this type of construction inadequate even though the construction has been first class. Notwithstanding the shortcomings of this type of road when put to such use many miles will continue to be built each year and here lies the source of one of our big maintenance problems.

Untreated waterbound macadam roads are generally subject to more or less rutting and pitting. By holding the crown to a minimum and having the metal of good width this tracking and rutting can be prevented somewhat. Yet the most effective thing is to keep traffic distributed.

The ordinary method of repairing a hole or depression in waterbound macadam is to make a waterbound patch. Whenever the foundation fails it is best to pick loose and shovel out the old base course and go down far enough to secure a solid foundation. New stone will then be added and compacted by hand tamping or better by rolling, after which screenings are added and waterbound in the same way a new road of this type is built. In case large areas are to be repaired it will prove more economical to do two-course work. To get the best results use as large stone as is practical, thoroughly key by tamping or rolling, apply screenings evenly and not more than are needed and work into a good grout. Advantage should be taken of rains when making such repairs as this will aid in bonding the newly made patch.

Patching waterbound macadam with a mixture of a bituminous material and stone is coming into quite common favor. It is a rapid way of making such repairs and is believed to be economical but the bituminous patch should be made only in case the macadam is to be surface treated. An important thing and which is so often neglected is to cut the sides of the hole vertically and thoroughly sweep out all foreign matter. Then paint the hole with the bituminous material being used in the mix, deposit the mix and tamp or roll. The larger the stone used the better, but the size will depend on the depth of the hole. A precaution should be taken not to use an excess amount of the bituminous material else the patch will not "set up" nor stay in place.

A great many of the old broken stone roads are badly worn and pitted and when in that condition should not be surface treated. In case there is a good thickness of compacted metal still remaining an effectual way of repairing this is to fill the holes and ruts with new stone, scarify lightly, shape the stone to a uniform cross section and roll thoroughly. Should the old metal be worn thin the problem is then one of reconstruction.

Gravel, preferably containing a small per cent of clay filler, not exceeding ¾ in. in size, is sometimes used as a top dressing for waterbound macadam. A badly worn metal can be greatly improved by its use. It binds quite readily and the surface is floated the same as a gravel road.

Maintenance Methods for Concrete Pavements

Concrete pavements, like all other types, must be maintained properly if they are to give maximum service. Maintenance of concrete pavements includes filling cracks and joints with tar or asphalt; repair of spots where the concrete has worn; replacing concrete in pavement cuts, and repair of joints which were improperly installed and which may have caused one slab to rise upon another. Methods of doing these things are described in a bulletin issued recently by the Portland Cement Association. The notes following are taken from the bulletin.

Organization.—The work required for maintenance should be under the direction of a single official, preferably the county engineer in a county organization, or the engineer of maintenance in a state highway organization. He should be provided with suitable equipment, and a place where the equipment and surplus materials may be stored when not in use. For ordinary maintenance work, a crew of three men with a light motor truck can do everything necessary on a 100 miles of concrete road in 30 to 40 working days each year. To secure the best results, a section of concrete pavement should receive especially careful attention during the spring following the first winter after completion of the pavement. If this season's work is well done, the maintenance requirements of succeeding years will be very slight.

Materials.—The materials required for concrete pavement maintenance are portland cement, sand, stone (pebbles or crushed rock) and bitumen. Portland cement can be obtained from any dealer in building materials. Sand and stone may be obtained in nearly all localities.

Bitumen for filling cracks and joints and for making small patches may be coal tar products, asphalt, or asphaltic products. The varieties of bitumen can be obtained in the form of standard commercial preparations made especially for the purpose. They may be obtained as preparations which require melting and application to the road while hot, or as preparations which may be used "cold" without melting or heating. The "hot" bitumens, at proper temperatures, flow quickly and fill all parts of joints and crevices immediately, but caution has to be exercised not to overheat the material. When overheated certain parts of the bitumen are "cooked out" and it is likely to become brittle after cooling. The "cold" bitumens are used chiefly for small patches after mixing with sand and stone, but [illegible] for filling joints and cracks. The "cold" bitumens do not flow so readily as do "hot" bitumens, hence they do not fill all parts of crevices immediately after pouring, and cannot be handled so rapidly.

Light Motor Car Outfit for Maintenance Work

It is good economy to purchase well known standard brands of commercial tars or asphalts. Materials of unknown composition or brand should be avoided as they may be entirely unsuitable for the purpose. This particularly applies to local by-products of gas plants which frequently vary so much in composition as to be unreliable.

Specifications for Tars and Asphalts. The following specifications for tars and asphalts may be of assistance in requesting proposals for bituminous materials or for testing unknown materials. These specifications are used by the Division of Highways, Department of Public Works and Buildings, State of Illinois.

Filling Crack with Bitumen.

Refined Coal Tar for Filling Cracks and Joints. The tar shall be homogeneous and free from water. It shall conform to the following requirements:

Specific gravity at 25°C. (77°F.)	1.220 to 1.280
Melting point	40°C. (104°F.) to 46°C. (115°F.)
Total distillate by weight.	
To 170°C. (338°F.)	not over 0.5%
To 300°C. (572°F.)	not over 15.0%
Specific gravity of total distillate, 25°C. (77°F.)	not less than 1.030
Melting point of residue	not over 75°C. (167°F.)
Solubility in carbon disulphide	75.0% to 85.0%
Inorganic matter (ash)	not over 0.5%

Asphalt for Filling Cracks and Joints. The asphalt shall be homogeneous and free from water. It shall conform to the following requirements:

Specific gravity at 25°C. (77°F.)	[illegible] to 1.100
Melting point	[illegible] to 60°C. (140°F.)
Ductility at 25°C. (77°F.)	not less than 30 cm.
Penetration at 25°C. (77°F.), 100 gm., 5 sec.	[illegible] to 120
Loss at 163°C. (325°F.), 5 hours	not over 1.0%
Penetration of residue at 25°C. (77°F.), 100 gm., 5 sec.	not less than 60
Total bitumen	not less than 99.5%
Per cent of total bitumen insoluble in 86°B. naphtha	19.0 to 28.0
Fixed carbon	[illegible] to 17.0%

Asphaltic Emulsion. The emulsion shall consist of asphalt, water and fatty or resin soap thoroughly emulsified. It shall be of uniform quality and of such fluidity that it will flow readily through the bunghole of a barrel. It shall not separate on standing and shall be miscible with water in all proportions up to the extent of one (1) part of water to one (1) part of the emulsion. It shall conform to the following requirements, all tests, except the bitumen determination, being made on dehydrated material:

Bitumen	not less than 60.0%
Specific gravity at 25°C. (77°F.)	not less than 1.000
Ductility at 25°C. (77°F.)	not less than 30 cm.
Penetration at 25°C. (77°F.), 100 gm., 5 sec.	150 to 200
Per cent of total bitumen insoluble in 86°B. naphtha	15.0 to 28.0
Fixed carbon	8.0% to 16.0%

The bitumen in the emulsion shall be considered as being 100% minus the sum of the percentages of water, of fatty or resin acids, of organic matter insoluble in carbon disulphide other than fatty or resin acids from the soap, of mineral matter and of ammonia.

Equipment.—The necessary equipment for maintenance of concrete pavement is simple and inexpensive. For periodical attention to cracks and joints, the articles needed are a heating kettle (mounted on wheels) for melting bitumen, one or two pouring cans, a stiff broom, a raking tool (made by any blacksmith) for cleaning out joints, and one or two shovels. If the pavement to be maintained is small in area, an ordinary one-horse express cart can be hired by the day to move this equipment about. Where large areas of city streets or extensive highway systems are to be covered, a light motor truck will be found convenient and economical.

When shallow surface patches are to be made with bituminous mixtures, a tamping iron in addition to the other tools will be found necessary. For cutting holes through concrete pavement a set of ordinary rock drilling tools, stone chisels and sledges are the only tools needed. For refilling holes cut through a pavement, the small amount of concrete required is usually mixed by hand. A 3 by 6 ft. mixing box, 8 or 10 in. deep, is a convenience but not essential, as the materials can be mixed on the surface of the pavement near the hole to be refilled. When water is not available near the spot to be repaired, a water barrel will be needed. A measuring box holding 1 cu. ft. is necessary for measuring the stone and sand. Such other items of equipment as may be needed will be mentioned in later paragraphs.

Joints and Cracks.—Clean out cracks and joints, using the sharp pointed metal raking tool. With a stiff brush or broom remove all loose particles and dirt. If the crevice is too narrow to permit cleaning in this manner, loose material can be blown out with an air jet from an auto tire pump. Be sure the concrete is perfectly dry. Fill the crack or joint with hot tar or asphalt. The filler should be used sparingly—just enough to fill the crevice and flush over the edges slightly. Take care not to use so much that an unsightly wide black strip is made across the pavement. Cover the filler immediately with coarse, dry sand.

When using a "hot" filler, DO NOT OVERHEAT in melting. Overheating shortens the life of these materials and will cause them to become brittle when cold. The filler should be heated to the temperatures recommended by the manufacturers and care exercised not to exceed these temperatures nor to maintain them for long periods or the material will be damaged. For an outfit having much work to do, a special asphalt thermometer, metal armored, will be a convenience. One of these to record temperatures from 200 to 400° can be obtained for about $7.50. Such a thermometer is extremely useful in controlling the amount of fire maintained under a heating kettle and in making sure a batch of the material is not ruined by overheating.

Shallow Surface Patches. Sometimes it is necessary to repair worn spots in a concrete pavement, where, due to faulty materials, improper mixing, or freezing while the concrete is green, the surface has worn away, leaving a shallow depression. Clean the area thoroughly from all dirt and loose material. Be sure the concrete surface is dry. Paint the area with a thin coat of bitumen, then cover with coarse, dry sand or crushed rock screenings. For depressions up to ½ inch in depth, first paint the clean surface of the concrete with bitumen, then fill to the surface level with a mixture of the sand or screenings and bitumen. This mixture can be prepared by placing a sufficient quantity of the sand or screenings in a mixing box, or on a mixing platform, pouring on just enough bitumen and stirring the mass with shovels until every particle is coated. Do not use too much tar or asphalt. Such mixtures may be made in stock quantities, with certain bitumens, and stored in the material shed for three or four weeks until needed. Tamp this mixture into the depression firmly and smooth off the surface to conform to the adjoining pavement, then paint the surface of the patch with a thin coat of bitumen and cover immediately with dry sand or screenings. To repair small holes where clay balls, bits of coal, wood, or other foreign materials have come out of the concrete, simply fill with the bitumen and cover at once with handful of sand.

Deep Patches. For patching holes more than an inch deep permanent repair is insured by trimming the hole to a depth of not less than 3 in., squaring up the edges and filling with new concrete. The edges of the hole should be trimmed with a cold chisel to make a vertical square edge for a depth of 1 in. below the surface of the pavement. The old concrete should be chipped away until perfectly sound material is reached. The hole then should be thoroughly cleaned and the edges and bottom wetted. Do not leave water standing in the hole. Mix new concrete, using as nearly as possible the same materials as used in the original pavement and in the same proportions, except that the mixture should not be leaner than 1 part portland cement, 2 parts sand, and 3 parts of pebbles or crushed rock. Use pebbles or crushed rock of a maximum size corresponding to about half the depth of the hole to be repaired. When mixing the concrete, do not use any more water than absolutely necessary to moisten the mixture and to hydrate the cement. The mixing should be very thorough and should be done immediately before the concrete is to be used. Place the concrete into the hole to be patched, tamping it firmly against the sides and bottom of the hole so as to leave no cavities. The hole may be slightly overfilled, as the subsequent treatment will reduce the volume of new material. After the material has been thoroughly tamped allow it to stand for 5 to 30 minutes. The tamping should then be repeated, and again repeated at intervals of 5 to 30 minutes so that it is tamped at least three times 5 to 30 minutes apart, before the final surface finish is given. The interval between tampings will be controlled by the rate at which the cement hardens and the air temperature. The concrete will harden more rapidly on hot days than on cool ones, and the treatment should be governed accordingly. The repeated tamping is very important as it takes up all of the shrinkage which occurs as the cement begins to set and insures complete filling of the cavity. After the last tamping, the surface should be worked evenly with a wooden hand float, special care being taken to produce a good finish at the edges of the patch and an exact surface contour conforming to the adjacent pavement.

After finishing the surface, cover the fresh patch with damp canvas or burlap until the concrete has thoroughly hardened. Then cover the patch with damp earth 3 or 4 in. deep. During hot or dry weather keep the earth cover moist by wetting down twice a day. Keep the moist cover on for at least 5 days; the traffic should be kept off the patch for 10 to 20 days, if possible, so the fresh concrete may harden properly.

If these suggestions are followed carefully and proper materials used, a patch will be produced which will unite perfectly with the old concrete and which can hardly be distinguished from the surrounding pavement.

Substantial barricades should be placed to keep vehicles away from new patches during the hardening, or "curing" period. Clearly legible warning signs should be posted both on the barricades, and in conspicuous positions beside the road three or four hundred feet each way from the repaired spot. Post red lanterns at night, chained and padlocked to the barricade, in sufficient number to indicate clearly the obstruction.

When it is not possible, on account of weather or traffic conditions, to make a permanent patch, a temporary repair may be made with a bituminous mixture. The spot to be repaired should be first trimmed out to sound concrete, leaving square, vertical edges all around the hole, and all loose material cleaned out. Paint the sides and bottom of the hole with a thin coating of bitumen.

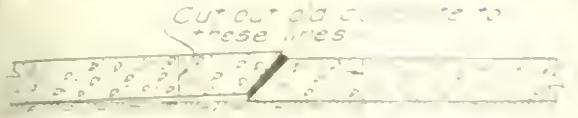
For holes from 2 to 3 in. deep, a bituminous mixture may be prepared by using a well graded combination of sand or crushed rock screenings and crushed stone. Do not use stones over 1¼ in. in size and in no case use stones which are larger than one-half the depth of the hole. The bituminous mixture may be prepared on a mixing platform or in a mixing box. Either the "hot" or "cold" bitumen may be used for this purpose. Use just enough to cover every particle of stone and sand in the mixture and work the mass thoroughly with shovels until this is accomplished. Such a mixture may be prepared in stock quantities and stored for several days or weeks, if necessary, before used. Tamp the mixture into the hole to be repaired, taking care that it is completely filled and that the mixture is firmly tamped against the edges. When the hole has been tamped level full, the surface should be given a spray or paint coat of the bitumen and covered with a liberal application of dry sand or stone screenings. If the patch does not extend entirely through the thickness of the concrete slab and the work is carefully done, a temporary repair of this kind will hold up under medium traffic for several months.

Replacing Cuts Through Concrete Pavements.—When necessary to cut through a concrete pavement to excavate for underground service pipes, or for other reasons, the methods of repair are similar to those outlined for deep patches. Where trenches have been dug in the sub-grade to get at service pipes, backfilling of these trenches should be done very carefully and the material thoroughly rammed into place, using water to assist in the settling. Well rammed fine gravel or sand in the surface of the sub-grade will aid in providing a good foundation for the replaced pavement.

The cut in the pavement should be [illegible] with concrete [illegible] in the preceding [illegible] patches.

Temporary repair of a cut through [illegible] may be made by tamping crushed rock or [illegible] filling it to 2 [illegible] in. below the [illegible] of the pavement, then fill the remaining space to [illegible] with the bituminous mixture described [illegible]. Such a repair will not hold up indefinitely [illegible] but it will permit traffic to go [illegible] repair can be made.

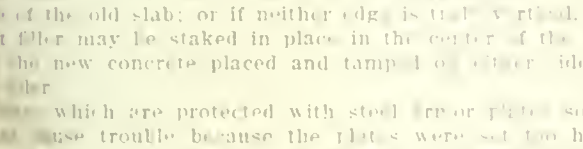
Uneven Joints.—Expansions on [illegible] will sometimes give trouble [illegible]



Joint Heaving, Due to Improperly Placed Filler

[illegible] The end of one slab may [illegible] raising an obstacle to traffic. [illegible] the [illegible] settle back into place within a few [illegible] remains high and requires attention. Cut out the concrete on the high side for a distance of 8 or 10 [illegible] from the joint clear across the pavement [illegible] to give truly vertical edges. If the subgrade is [illegible] dry or tightly packed old gravel or [illegible] and refill with sand or sandy loam [illegible] to the [illegible] subgrade level. The cut through the pavement should then be refilled with concrete [illegible] methods [illegible] for permanent repair of deep [illegible]. In most cases it will not be necessary to form an expansion joint at these points. If for any reason it is thought necessary to [illegible] an expansion joint, the filler ([illegible] bituminous filler) may be placed directly against the vertical edge of the old slab; or if neither edge is truly vertical, the joint filler may be staked in place in the center of the cut and the new concrete placed and tamped on either side of the filler.

[illegible] which are protected with steel armor plates sometimes cause trouble because the plates were set too high. This causes undue wear to the adjacent pavement and an uncomfortable jolt when vehicles pass over the joint. If there are only a few such joints to be repaired, the projecting steel plate can be filed down to proper grade with a large flat file or rasp. For convenient use, the file should be fastened to the 2-inch edge of a short length 2 by 4 in. or 2 by [illegible] lumber. Drill a hole through the file near each end, [illegible] out these holes to receive screw heads and fasten the file to the wood with short screws. If there are many joint plates to be trimmed down, the work can be done to better advantage by means of a motor-driven carborundum or emery wheel, mounted on a small wheeled truck. If the adjacent concrete surface is too high, it should be trimmed down with a cold chisel to the level of the surrounding pavement before grinding is commenced, so that when the job is completed there will be no break in the regularity of the surface. The plate should be ground low enough so that it can be later covered with an application of bitumen and sand, so that no sharp edges will be left exposed to [illegible] of vehicles.


Position of new joint filler
Trim to vertical edge at least [illegible] surface
Fill with new concrete
Tamped sand or [illegible]

Method of Repairing Heaved Joint

High joint plates are somewhat troublesome [illegible] but the increased comfort and [illegible] and the elimination of undue wear to the [illegible] will repay the expenses involved many times.

Sub-Grade Settlement.—When [illegible] serious extent, three transverse cracks [illegible] formed, with the middle crack approximately [illegible] low[illegible] of settlement. Unless the support of the pavement has been removed too completely, and if repair [illegible] be undertaken before the pavement is further [illegible], the slab can be restored to proper grade by careful [illegible]. Tunnel under the lowest point of the slab for the full width of the pavement [illegible] and [illegible] the pavement [illegible] excavation is opened [illegible] full [illegible] the full width of the pavement [illegible] the pavement [illegible] slab with uprights 6 by [illegible] and remove the [illegible] material [illegible] the slab and the subgrade [illegible]. The tunnel can then be [illegible] at a time and [illegible] backfill. When [illegible] have been closed [illegible] at once.

Portable Repair Shops for Motor Truck Fleets

Machine repair shops mounted on motor trucks, which were extensively used by the government during the war to care for its large fleets of trucks at home and abroad, are destined to play an important part in facilitating the successful operation of the ever increasing fleets of trucks operated by large [illegible], contractors and road builders throughout the country, according to C. J. Van Landeghem, Transportation Engineer of the Four Wheel Drive Auto Co., Clintonville, Wis. With the increasing use of fleets of trucks in various lines of business the machine shop truck, as a flexible medium for keeping fleets of trucks in constant running order, at a minimum loss of time, will become as necessary and vital a factor for commercial use as it was during the war, is his prediction.

Machine Shop Truck "Ready for Action."

"The continuous operation of every truck is an important consideration with a fleet owner, and in this respect the machine shop truck has proved itself a time and money saver through its ability to go direct to the crippled truck and put it in shape at a minimum of time," says Mr. Van Landeghem. Mounted on the chassis is complete equipment to handle any kind of repair job. A separate motor furnished the power for operating the various machine tools. This embraces such mechanical apparatus as a drill press, screw cutting lathe, electric grinder, blow torch, welding outfit, forge and more than 1[illegible] other pieces of machinery and tools.

Each tool and piece of machinery has its own location, insuring compactness when the end and side panels are up and the truck is in motion.

Bidding Prices on Paving in New York City.—Bids on paving work received May 25 in the first letting of the season in the Borough of Manhattan, New York City, showed a great increase over the average prices for 1919. The bid prices ran as follows:

Concrete on [illegible] contracts, per cu. yd.	[illegible]
Concrete on [illegible] contracts, per cu. yd.	[illegible] to 12.00
Sheet asphalt, per sq. yd.	[illegible]
[illegible] per sq. yd.	[illegible] to 7.51
The average prices in 1919 were:	
Concrete, per cu. yd.	$8.29
Sheet asphalt, per sq. yd.	2.77
[illegible] per sq. yd.	5.64

The Problem of Unrest in Engineering Societies and Suggestions for Its Solution*

By LEONARD METCALF.

Engineers Unskilled Salesmen of Their Services.—Engineers have not yet learned to fairly appraise their services and to sell them profitably. In the gigantic task of the national preparation for war, engineers have been self-sacrificing to the point of impoverishment. In the public service and in many cases of private service their inadequate salaries have stood practically still during the war period where the wages of other labor have doubled and trebled and more. Brains have been at a financial discount; brawn, better organizer, has fared better.

Now, with the return of peace, the struggle for existence has been intensified. Civil engineers, employed upon the construction and maintenance work of the railroads of this country have received lower compensation than have engine drivers, brakemen and clerks. Many designers in our shipyards have received smaller compensation than the carpenters and mechanics. The laborer who works with his hands has been better paid often than the man who worked with his head. Day laborers have drawn higher pay during many months than the foreman directing their work. There is no justification, in fact or in productivity, for this condition.

Meanwhile, the purchasing power of our incomes has been nearly halved, or costs have been doubled. This condition must and will pass, though unhappily lack of effective co-operation and of past experience in meeting such situations are likely to delay the transition; but the world recognizes today, far better than it did before the war, the character, breadth and scope of the work of the engineer and its dependence upon it.

In public works and public utility service the engineers have too long undervalued their professional service and been content to attach too great weight to continuity of service and long tenure of office.

The constant tendency toward the building up of political machines in our cities has militated against fair treatment of the engineer, to whom, with rare exception, politics are distasteful.

So, too, the development and growth in power of large concenstruction concerns, many of them handling not only the scientific and physical but also the financial elements of their problems, while giving greater opportunity and return to the engineer of exceptional talent, resourcefulness and administrative ability, sometimes tend toward the exploitation of the services of the engineer and make the outlook of the engineering staff as a whole less attractive financially and more keenly competitive. To the man above the median line the outlook is probably much better today than ever before; to him below the line, perhaps, worse, certainly but little improved. But the median line is higher and standards of work are constantly being bettered, advance in compensation following of necessity, though often slowly.

Reasons for Lack of Active Interest in Engineering Societies. As I have attended engineering society meetings in different parts of the country, often when but a handful of men were present to hear a paper prepared with care and labor by some fellow-member, I have asked myself, "What is responsible for the failure of the men to turn out in larger numbers? Where are the younger men?"

Some of the causes are obviously the diversification of interests, specialization, improvement in means of communication, the smaller consumption of time involved in reading or skimming an article instead of listening to its presentation, and perhaps, most important of all, the multiplicity of demands upon our available time.

It is to be remembered, too, that engineering as a science is young, scarcely half a century old. Many of the pioneers in our profession are happily still with us. The need for co-operation of engineers in such societies was more urgently felt in those early days of the formative period than today, because of the lack of precedent, record and knowledge. But the societies themselves have constantly grown in power.

Now comes a new generation of engineers, prepared by the technical schools, instead of by hard experience, able to find good precedent, well classified knowledge and epitomized statement of the state of the art in many fields of engineering; more sophisticated, but less keen for discovery until competitive struggle challenges courage and awakens ambition. Then real progress begins and knowledge takes on new significance, new value, as it has from generation to generation, to the young man.

The Present Problem of Engineering Societies.—The present problem of engineering societies is that of rousing the younger men to help themselves, of bringing home to them what they will otherwise learn regrettably late, that the engineering societies offer the open door to acquaintance and happy relationships with men of their own profession, to friendly service and effective co-operation, to the development of winsome personality and broader life.

While it is the younger men who suffer from failure to justly appraise the situation, we older men must bring home to them, as would father to son, these obvious facts, clear to us because of our broader experience with life. Many of the younger men do not appreciate these facts. They find it exceedingly difficult to overcome their shyness and to mingle with men to whom they have not previously been introduced. They naturally shrink from putting themselves forward and from making the first advance, even where they are ready to go more than half way in the effort to meet men. The society must find a way to overcome this difficulty, for the feeling is a natural one and widespread. There should be present at every meeting members of a committee conspicuously labeled, who should act as welcoming hosts and introduce new members to one another, and see to it that no man can feel himself out of the circle or of common touch. Many organizations, like the chambers of commerce and rotary clubs, have recognized this need as a vital one and have succeeded in overcoming this difficulty, supplanting shrinking diffidence with warm-hearted good-fellowship.

It is important, too, that the coming generation of engineers should not lose the advantage already gained in our generation, of the maintenance of friendly relations with one another, even though in active competition. Distinguished foreign engineers, who have visited us, have repeatedly spoken of the marked contrast in this respect, between conditions in the United States and abroad, and of the greater advantage of the cordial relations here existing. We should broaden and strengthen these ties, and make them more helpful.

Unionization Not the Solution.—The fields of the professional society and the labor union are similar to a limited degree only, quite distinct in many respects. The labor union interests itself primarily in the material welfare of its members—the wages, hours of employment, conditions of work and similar questions. Its success depends upon its power; its power upon its members; its memberships upon the breadth of it aims and simplicity of requirements for admission. As mere numbers largely determine its strength, the selective process cannot be carried far in limiting admission to its brotherhood.

The professional society, on the other hand, may advantageously carry the selective process much further, and practical experience has demonstrated that with the development of the state of the art, the process of specialization leads to the formation of new societies and associations of men highly skilled in narrower fields. While the professional society may establish codes of ethics, general scale of compensation and other measures helped to the material welfare of the engineer, its primary function must ever be to broaden technical knowledge, to improve engineering methods and standards and to give facilities for the advantageous interchange of professional knowledge, technique and opinions.

The labor union exercises its influence through organized force or economic pressure; the professional society rather through improvement in methods, efficiency and in standards of practice. The means used for accomplishing betterment are in marked conflict in principle and application. There is little hope of their unification. The best that can be looked for is the maintenance of such relations between the engineer's labor union and his professional society that the young engineer who joins the labor union may not be denied entrance to the engineering society at a later date, when his professional spirit has grown and developed and he can discriminate intelligently between the two fields of activity.

All experience has shown that the most helpful and enduring field of work for the engineering societies must be the educational and professional rather than the personal.

While no doubt organizations devoted to welfare work may build up good reputations for fair consideration of the public interest, as well as that of its members, just as in the field of organized labor certain organizations have the reputation of being better officered and managed than others and of having scrupulous rather than unscrupulous regard for contractual relations, the building up of the prestige of engineering societies is a much more difficult task. It requires a nice discrimination between feasible and impossible action, between productive and nonproductive fields, between desirable publicity and danger of exploitation, and a clear conception of the difference between progressivism and radicalism.

---

*From an address presented March 17 at the annual meeting of the Boston Society of Civil Engineers

It is particularly important at this time that we should build on the past, safely and wisely, adapting our societies to meet present problems the better, rather than to throw experience of the past to the winds and to embrace supposedly new ideas, often idealistic and attractive in principle but impracticable of enforcement and therefore visionary.

Informal Meetings of Younger Men to Discuss Their Problems.—One of the most promising lines of work lies in effort to bring together effectively in this society the young engineers of different offices in this city and neighborhood interested in special problems of design. These meetings should tend to broaden acquaintanceship, stimulate interest and give opportunity for really effective educational work. During the past year this movement was instituted, and three such meetings have been held at which there were presented and discussed some interesting recent problems in foundations for structures on the water front. From 35 to 50 of the younger men of the society attended each of these meetings, and a lively and helpful discussion has resulted. The interest aroused and the response of the younger men have been most friendly and encouraging. Their comment has been favorable and appreciative.

The meetings can probably be made more helpful and the diffidence of the younger man in speaking be better overcome, by limiting the attendance to the younger men with but two or three of the older men, particularly experienced in the subject matter under consideration, present to assist in broadening and drawing out friendly discussion and comparison of ideas.

The discussions can be vitalized by taking up specific actual problems recently faced by these young engineers in their daily work, with which they are therefore so thoroughly familiar that they can speak upon them informally without effort. Additional meetings can then be held, to broaden the examples of the application of the theories involved. Oral presentations are to be encouraged, rather than written ones.

In this way groups of capable young engineers can be drawn together and activity of interest in the work of the main society be gradually but materially stimulated.

Effort should be made to bring the older men into friendly touch with the younger men in every way possible and to the advantage of both.

Individual Efforts.—It is not to be supposed that the older men are alone responsible for the upbuilding of our engineering societies. This responsibility is shared alike by the younger men. Nevertheless, it is true that the former realize more clearly, as a result of longer experience, the importance to engineers, of active engineering societies, and it is therefore incumbent upon them to bring home this fact to the younger men, that valuable time may not be lost, and that the younger men may not wake up later to a realizing sense of what they have lost in failing to take active part in constructive efforts in this field during their early professional lives.

It is to be clearly remembered that the society and we, as individuals, benefit only as we put effort into its meetings. Who has not felt the difference between friendly interest and of aloofness and cold criticism at meetings of one kind and another? How are conditions of the whole to be bettered if the individuals sit by and fail or refuse to act? How often the flood gates of animated discussion have been opened by the courage of one man in asking a question or two—perhaps a foolish question in the eyes of some. If members would all look at the matter from the point of view of the interest of the society rather than of their personal feelings, what progress could be made! What vitalizes an organization? What, in the slang of the day, gives it "pep"? The enthusiasm of a few live men and the participation of large numbers of its members in its activities—participation, I say, and not absorption. Participation involves giving out as well as taking in. Don't be clams, but, like the bee, spread the pollen while you sip the honey, and later share the honey with others.

Winter Hauling for Road Work in the Dakotas, Minnesota and Wisconsin

Winter road work consisting mainly of hauling gravel for surfacing has been carried on for several years past in some of the counties of northern Wisconsin. The advantages obtained here are (1) the greater availability of the pits in winter, (2) the larger number of teams available, and (3) the lengthening of the construction period. With the ground frozen it is possible to haul across swamps and streams as well as over sandy soils and wood roads with sleds, where summer hauling with teams and wagons would be impossible. A material reduction in the length of haul is often secured, and a better selection of material is possible. The yardage which can be hauled is much greater per team, varying from 3 to 6 cu. yd. to the load for one team and from 5 to 8 yd. where four horses are used, the variation being due to road and weather conditions. In farming communities it is hard to secure teams for road work during the summer months. During the winter months, however, a great many farm teams represent such an expense that the owners welcome an opportunity for putting them to work. Then, too, the contractor, or the county, where work is done by force account, is able, through carrying on this winter hauling, to retain the best men and promote efficient organization. The methods employed in this winter road work are described by Mr. E. G. Edwards, Highway Engineer, U. S. Bureau of Public Roads, in a recent issue of "Public Roads," to which we are indebted for the matter in this article.

Trap Loading of Sleds on Winter Road Top in Marshall County, Minnesota.

Preparatory Work and Equipment.—For good results preparation should be made in the fall for the winter's work. The pits should be stripped and approaches prepared before the ground freezes. Hauling should begin, where this is practicable, as soon as the ground freezes, using wagons until there is enough snow for sleds. Hauling should be continuous, to maintain a solid roadbed for the sleds, as where the snow is packed hard after each fall the track holds up better during the periods of thaw.

As a 7-yd. load of gravel weighs something over 10 tons, a runner 3 in. wide, with a bearing length of 6 ft., or about 8 ft. long, including the rise, is required. Using smaller runners on a well maintained snow road is a mistake as the hauling capacity of the teams is materially reduced.

Logging sleds which have been cut down from a 6-ft. 8-in. to a 4-ft. 6-in. gage are commonly used. Mr. Edwards' observation leads to the belief that cutting down the gage is a mistake. He has observed logging teams hauling 15-ton loads on 6-ft. 8-in. gage sleds with less effort than that required to haul 8 or 9 tons of gravel on similar sleds with the narrow gage. This is accounted for by the fact that where the wide gage is used the track is never cut up by the horses' feet. It always gives a smooth, clean bearing on the full length of the runner, while the horses cut up the track for the sled of the narrow gage.

Icing the track is practiced to some extent. For this purpose a tank mounted on a sled is used. A properly regulated stream of water is allowed to run from the rear of the tank into each of the tracks as the team hauls it along the road. With the 6-ft. by 8-in. gage very little renewal work is required, once the groove has been well iced.

The boxes for hauling the gravel vary from 4½ ft. to 7 ft. in width and from 2 ft. to 4 ft. in depth, with a usual length of 12 ft. The loose planks forming the bottom are usually [illegible] in. thick and from [illegible] in. to 8 in. wide, the narrower planks being easier to manipulate in dumping. In some cases it is necessary to uncouple the sled and haul the front and rear sections out separately after dumping the gravel.

Removing Snow with Blade Grader.—Where the road has been graded the previous season, as is usually the case, the snow is cleared away by the use of a blade grader and hand shoveling for a width about [illegible] ft. less than the required width of surfacing. The full amount of gravel is then deposited and the gravel strip is widened and shaped to the proper cross section in the spring after the frost is out.

Gravel Surfacing Placed in Winter, Oconto County, Wisconsin.

Where the frost goes out gradually the shoulders of the road thaw out first. The frozen road underneath the gravel thaws out more slowly and drains out through the shoulders. This leaves the road in good condition for shaping up with a road machine. In case of warm rains, coming before the road thaw out, however, the frost may be drawn from the subgrade under the gravel before the shoulders thaw out. In this case more time and labor is required to get the road into shape. The cost of shaping the gravel on the road in the spring averages about 10 ct. per cubic yard.

Where the gravel is hauled before the grading is done it is stock piled, usually at the rate of 8 to 10 piles per mile, care being taken to place the piles where the gravel will be easy of access and not interfere with the construction work. Rehandling from the stock piles to the road costs about 35 ct. per cubic yard.

Cost of Loading and Hauling.—Methods used for loading at the pit are practically the same as in summer. Hand loading, teams and scrapers with a trap and elevators with teams are commonly used.

The cost of loading runs from 25 ct. to 45 ct. per cubic yard. Spreading costs from 10 ct. to 20 ct. The cost of hauling depends upon the weather to a considerable extent, as [illegible] loads [illegible] be hauled during and for a day or two after [illegible] period.

The average cost where the haul is from 1 to 7 miles runs from [illegible] ct. to [illegible] ct. per mile per cubic yard. These rates are based on $4 per day for labor and from $7.50 to $[illegible] per day for man and team.

At [illegible], [illegible] County, Wisconsin, a disintegrated granite is taken from a quarry where some blasting is required. Here the cost of drilling, blasting, and loading is about $1 per cubic yard. The cost of an average 5-mile haul to stock piles is about $[illegible] and the cost of the placing and spreading to be done later is estimated at 10 ct., making the total cost of material on the job $[illegible] per cubic yard.

On Federal-aid project No. [illegible], Goodhue County, Minnesota, 15 yd. were hauled on two wagons, pulled by a 6-horse team handled by one teamster. The cost of this was 95 ct. per yard for loading and hauling the first mile, and 50 ct. per yard per mile for additional haul, based on $4.50 per day for labor and $8 per day for teams. During the summer it is impossible to haul more than 1.5 yd. on a wagon due to sandy roads.

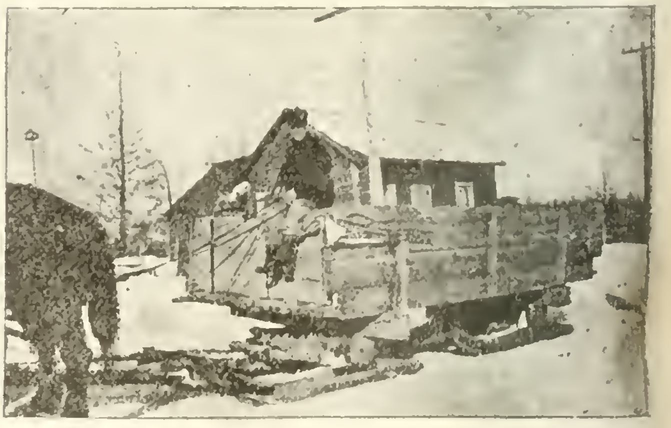
Hauling with Heavy Trucks on Frozen Roadway.—On project No. 54, Lac qui Parle County, Minnesota, steam shovel outfits were used to load gravel hauled by trucks of 5-yd. capacity. The roads were practically clear of snow and the hauling was done both rapidly and economically over the frozen earth. It would have been impossible to use heavy trucks on this work during the summer months, and considerable lost time would have been inevitable in using teams and wagons or light trucks.

On project No. 55, in the same county, an outfit of 10 1½-yd. trucks, with pneumatic tires with an average haul of 3 miles, made a very good record. The loading was done by hand shoveling, five extra shovelers working at the pit with the truck drivers helping to load. The drivers were paid by the yard according to the length of haul, and they averaged 20 yd. per day on the average haul of 3 miles. The contract price on both these projects was 95 ct. for loading and hauling the first mile, and 48 ct. per mile thereafter. Both of these projects are in a heavy clay loam soil where it is practically impossible to haul loads over the dirt roads during wet weather.

In Marshall County, Minnesota, on a section of swamp road, the peat was used to build up the grade about 3 ft. above the swamp. By the use of a disk harrow and a 10-ton roller the peat was compacted into a fairly sound roadbed, which enabled hauling by wagons in the fall before the snow came. As soon as there was enough snow the hauling was done on sleds, 3½ yd. to the load, the output per team being more than doubled.

On Federal-aid project No. 12, in Minnehaha County, South Dakota, gravel was hauled by mule teams and dump wagons. Twenty teams were used in the hauling and they made six trips in a 10-hour day on a 2-mile haul. The loading was done through a trap, by teams and fresno scrapers. Extra teams were used to double up on hills between the pit and the road. This contractor had 13 Ford trucks with 1¼-yd. dump bodies, which were loaded by a steam shovel and as there was very little snow during the winter of 1919-20 they gave very satisfactory service in getting the gravel onto the road.

Advantages of Winter Hauling.—From his observations, based on work inspected and data obtained during the winter of 1919-20, Mr. Edwards concludes that winter hauling of surfacing materials offers substantial advantages where conditions are favorable and when properly planned and handled.



Sled Used in Winter Hauling of Gravel. With This a Load of 6 Cu. Yd. Was Hauled by Two Teams 7½ Miles Over Grades Up to 6 Per Cent.

Where the hauling can be done on sleds each team can haul at least double the quantity possible on wagons, even over roads where summer hauling on wagons is practicable.

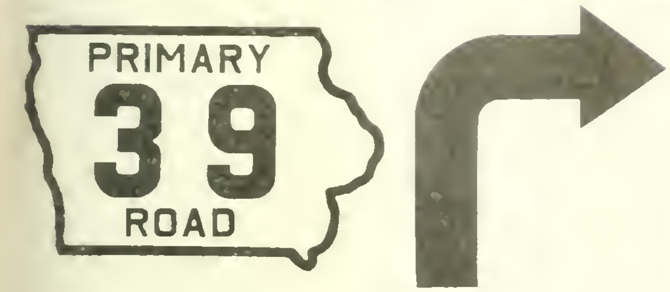
During the summer and fall of 1919 in western Minnesota and the Dakotas, where gravel hauling on heavy trucks and with wagons of large capacity, drawn by tractors, was attempted, serious damage to the subgrade and much delay due to rainy weather invariably occurred.

On the gravel road with the [illegible] trucks [illegible] the heavy trucks, [illegible] were able to operate at full capacity without [illegible] to traffic or damage to the road, during the [illegible]

In many [illegible] the contractor [illegible] the grading [illegible] the line for [illegible] in the fall. The newly graded road, unless the gravel surfacing can be placed [illegible] in poor [illegible] the traffic in the spring and the maintenance work [illegible] to keep the dirt [illegible] in shape for traffic [illegible] greater than [illegible] in [illegible] the gravel surfacing while it is being [illegible] by the traffic.

Road Sign Painting Week for Iowa Counties

A cooperative road sign painting [illegible] in practically every county in Iowa. During the period [illegible] standard symbol and [illegible] painted [illegible] the primary roads [illegible] through [illegible]. The state road numbering is similar to that in [illegible] middle western states. Wisconsin [illegible]



Number for Primary Road.

[illegible] for marking turns. As shown it [illegible] right. Reversed it indicates a turn to the left.

[illegible] first to adopt it and was in turn followed by Ohio, [illegible] Illinois, Michigan and Nebraska. In this system [illegible] important main traveled road between important transportation centers is given a designating number. The number is painted on telegraph, telephone or specially erected poles at every intersection, turn and cross-road between these points, also at times at one or two points between cross roads. The traveler or anyone using the road, once he learns what route number leads to his destination simply follows the numbers as they appear from point to point without worrying about maps or guide books. If road intersections are properly marked so that the routing is clear, he should have no trouble in following the numbers to his destination.

So far as possible numbers on important interstate [illegible] through Iowa have been given numbers corresponding with the number of the same road in adjoining states. When Iowa started numbering her roads it was found that the Jefferson Highway was No. 1 in Minnesota. This number was assigned to the same route in Iowa. The River to River road in Illinois was No. 7 and became No. 7 in Iowa. The River to River road it may be mentioned was the original painted trail road. Its sign, the white band on telegraph and telephone poles at turns and cross roads, was painted entirely across the state from Davenport to Council Bluffs in a single day 10 years ago. The Blue Grass trail is No. 8 in both Illinois and Iowa. The Red Ball is No. [illegible] in Iowa and Minnesota and the North Iowa Pike, now part of the National Parks Highway, is No. 1[illegible] in Iowa and Wisconsin. No. [illegible], a north and south road through [illegible] Albia, Oskaloosa, Tama, Waterloo and [illegible] is No. [illegible] still in Minnesota to Rochester.

The primary road system comprises [illegible] miles of highway selected from the county and township road systems with the idea of developing a [illegible] state system of highways. Township and county [illegible] are planned with the idea of service to [illegible] township or county. In the state primary system [illegible] were to be largely ignored and a system [illegible] with the idea of service to the entire state.

Out of 1,068 cities, towns and villages in Iowa 556 lie on the primary road system. [illegible] are not [illegible] reached [illegible] the [illegible] in [illegible] or [illegible] road [illegible] lined up with the [illegible] with every other road [illegible] and the [illegible] of [illegible] developed [illegible]. In general [illegible] at least one north and one east and west road.

The adopted [illegible] is a uniform [illegible] over the entire state [illegible]. A [illegible] band was painted on the pole first. [illegible] the words "Primary Road" were painted [illegible]. The symbol follows the outline of the State of Iowa with the word "Primary" [illegible] with the number in the center. [illegible] To show turns at intersections [illegible] pointing to either the right or the left [illegible]. When no arrow is in sight the driver [illegible] knows that he [illegible] straight ahead.

Where telephone and telegraph poles will be utilized [illegible] the present it is intended to adopt some standard form of [illegible] as a permanent system to keep the system [illegible] number also any other directions which it may be [illegible] to have placed on it. The standard adopted [illegible] also be such that town distances and other information can be placed on it.

Pavements for Industrial Housing Developments

In designing the roadways and sidewalks for a housing development the conditions that have to be taken under consideration are somewhat different from those found in ordinary street work. How this work was handled for the Loveland Farms Development of the Youngstown Sheet & Tube Co. at Youngstown, O., was told by Morris Knowles and John M. Rice, engineers for the development, in a paper presented at the last annual convention of the American Society of Municipal Improvements. The notes following are abstracted from the paper.

The Loveland Farms development comprises a triangular area of 220 acres just within the corporate limits of Youngstown. Adjacent developments had been platted on the rectangular plan, which requires a similar arrangement for the adjoining portions of Loveland Farms. However, the topography of the site is unsuited to this method of subdivision. Economy of earthwork and desirable appearance are both obtained, in this instance by permitting streets to follow the natural contours, which are approximately arcs or circles about the summit, or southwestern corner of the tract, as a center. The final street plan meets these conditions in a pleasing manner and skilfully joins the curved streets of the interior with the rectangular arrangement at the boundary. Interesting features of this plan are the provision for a business and community center near the summit mentioned, the attractive development of a curved street plan and the reservation of spots of natural beauty for park purposes. The curved streets, together with the use of park spaces at various street intersections, afford a most desirable appearance and contribute materially to attractive settings for dwellings.

The entire tract contains approximately 46,000 lin. ft. of street, of which some 31,000 ft. or 67 per cent of the total are curved. The net area of saleable land is 156 acres, or 71 per cent of the entire tract, which is divided into approximately 1,060 lots, giving an average area of 0.15 acre per lot. Parks and streets compose 5 per cent and 24 per cent, respectively of the total area. Lot frontages vary considerably with location, the minimum being 42 ft. The company has constructed some 400 houses and has approved comprehensive plans for future extensions of this work.

Design of Roadways.—In connection with the design of the roadway system, the subjects requiring careful consideration were the governing dimensions of street cross-sections and the choice of types of pavement. In all cases the final determination was based on effect desired or on fundamental services to be performed. In considering the governing widths of street cross-sections, it was deemed essential that streets should have an attractive appearance, in keeping with the surroundings, without the use of expensive methods of securing desirable results. A prominent feature of the Loveland Farms development is the provision of ample space around dwellings, as shown in the ample lot-frontages and the distance between the building and the property line. It was believed that this spacious impression should be consistently carried out within the street areas. This does not mean however, that sidewalks of extra width should be used, but rather that the effect of spacious lawns should be aided by provision of lawn spaces of ample width between sidewalk and curb. Sidewalks and paving widths should be chosen with reference to the traffic requirements of the particular street in question, both appearance and economy being served in residential streets by the adoption of minimum widths which provide proper service.

Within the limits of the city of Youngstown, streets have a minimum width between property lines of 50 ft. which, in minor residential districts, is considered wider than necessary. At Loveland Farms, however, these restrictions do not apply. It is necessary, however, that proper provision be made for main traffic streets to the satisfaction of the Platting Commissioner of the city. A consideration of adjacent territory indicated that there would be no traffic of appreciable volume passing through the tract. To the west of Pine Hollow, a natural park interposes a barrier to east and west traffic, which is expected to be permanent, while in the north and south direction the boundary streets of Loveland Road and Poland Ave. afford ample provision for future conditions. Accordingly, the widths of streets were designed to permit proper access between the central business districts and the various portions of the tract, together with provision for light vehicle traffic from adjacent communities. After careful consideration, standard street widths of 40, 50 and 60 ft. between property lines were adopted.

Pavement Widths.—Experience with various similar developments has indicated that purely residential streets can be well served by a lesser width of pavement than is customary in usual practice. A study of the traffic requirements of this district finally led to a conclusion that the pavement widths measured between faces of curbs could be taken as 18, 24 and 32 ft., respectively, for the 40, 50 and 60-ft. streets. Sidewalks were given 4-ft. widths on the 40-ft. streets of secondary importance and 5-ft. widths in all other sections. All sidewalks were placed with the inner edge 1 ft. distant from the property line, which provided for the various streets a parking strip between sidewalk and curb varying in width from 5½ to 7½ ft.

Factors in Selecting Type of Pavement.—In considering the type of pavement to be constructed, various characters of surfacing were compared with an ideal material by assigning numerical values, or weights, to the various desired qualities of service. Table I indicates the weight assigned to these various qualities by several authorities and the weight assigned to these qualities for Loveland Farm conditions.

Table II gives a summation of these various weights for the types of pavement considered, and therefore a numerical index of the desirability of the various types for the particular local conditions. It will be noted that cement concrete approaches most closely to the ideal pavement for most thoroughfares and minor streets, followed by bituminous concrete, brick, bituminous macadam and waterbound macadam in the order named. The cement-concrete pavement is further recommended by the fact that it can be made to serve at any time as the foundation for a bituminous wearing surface.

In the selection of pavements for the various streets of Loveland Farms, the conclusions as shown in Table II were modified in the following manner. The main traffic streets were provided with a bituminous concrete pavement for the reason that this type is nearly as high in index value as cement-concrete, while presenting a more desirable appearance, and being well adapted to fast-moving traffic. On various minor streets cement-concrete was extensively used. While the general use of plain cement pavement has not been entirely satisfactory in all cases, the excellent results obtained in many localities indicate that sufficient care in construction will result in satisfactoy pavement. While macadam pavements are not favored for heavy traffic, particularly in localities, such as this, which have clay subsoil, it was felt that bituminous macadam afforded a desirable pavement for certain light traffic streets.

On the steep grades near Poland Ave., brick and waterbound macadam are the only pavements which were considered as giving a satisfactory foot-hold for horses. Brick has accordingly been recommended on the streets which will be subjected to the heavier traffic, while waterbound macadam is used on the smaller streets where the traffic requirements will not warrant an expensive pavement. In addition, water-bound macadam was selected for various other minor streets which will carry only the lightest residential traffic.

TABLE I.—RELATIVE VALUES OF THE VARIOUS QUALITIES OF AN IDEAL PAVEMENT.

[illegible]	U. S. Dept. of Agriculture, Forestry Service Circular 111	Tillson.	Baker.	Sprague.	Knowles for Loveland Farms. Thoroughfares.	Knowles for Loveland Farms. Minor streets.
First cost	14	14	15	14	14	20
Durability	[illegible]	21		21	21	21
Ease of maintenance	10	10	20		13	13
Ease of cleaning	[illegible]	15	10	[illegible]	13	12
Sanitary quality	[illegible]	12	[illegible]		10	10
Non-slipperiness	7	7	5	[illegible]	7	5
Acceptability	4		15	[illegible]	8	8
Low tractive resistance	11	15	10	20	10	7
Favorableness to travel	1	5			4	4
[illegible]	100	100	100	100	100	100

Paris to Municipalize Street Car Lines.—According to a press report, the department of the Seine, which is Paris and its suburbs, beginning next year will take over all surface transportation lines. Payment is to be made in thirty annual installments now fixed at nearly 40,000,000 francs each. There are 117 street car and forty-four autobus lines operating 2,540 cars and busses. The companies are capitalized for $420,900,000 francs. The city and the department formerly operated the surface transportation systems, but the franchises were given to corporations that have evolved a puzzling network of lines, but few of which give transfers. The two subway companies are not involved in the deal.

490,000 Motor Vehicles in Illinois.—Records from the office of the secretary of state of Illinois on June 15, show in Illinois up to that date, 135,689 pleasure car licenses, 54,389 trucks, 5,723 dealers, 7,630 motorcycles, 177 tractors, with total fees of $5,240,258. The total number of truck and passenger car registrations for all of last year was 478,614. For less than half a year, the 1920 registrations of trucks and passenger cars is 490,078—a gain of 11,464. The total amount of money collected in 1919 was $3,262,176, as against $5,240,258 for the six months of 1920.

Road Building in Kansas.—At the present time 25 counties of Kansas are constructing roads under the benefit district plan, the total contract price of which is $9,177,916.

TABLE II.—COMPARATIVE VALUES OF DIFFERENT PAVEMENTS FOR LOVELAND FARMS.

Pavement qualities.	Waterbound macadam. Thoroughfares.	Waterbound macadam. Minor streets.	Bituminous macadam. Thoroughfares.	Bituminous macadam. Minor streets.	Bituminous concrete. Thoroughfares.	Bituminous concrete. Minor streets.	Cement concrete. Thoroughfares.	Cement concrete. Minor streets.	Brick. Thoroughfares.	Brick. Minor streets.
First cost	[illegible]	20	12	16	8	11	9	12	6	8
Durability	[illegible]	19	10	15	16	18	16	18	18	19
Ease of maintenance	[illegible]	[illegible]	7	7	9	9	11	11	10	10
Ease of cleaning	[illegible]	[illegible]	[illegible]	8	12	11	12	11	11	10
Sanitary quality	[illegible]	[illegible]	[illegible]	7	9	9	9	9	9	9
Non-slipperiness	[illegible]	4	6	5	6	5	6	5	7	5
Acceptability	[illegible]	5	5	5	7	7	6	6	6	6
Low tractive resistance	[illegible]	4	6	5	8	5	9	6	8	6
Favorableness of travel	[illegible]	[illegible]	[illegible]	3	4	4	4	4	3	3
Total	[illegible]	[illegible]	65	71	79	79	82	82	78	76

Necessary Steps for Development of Comprehensive Street Improvement Plan

In an article in a recent issue of [illegible] Engineer Mr. James W. Routh, Director of the Bureau of Municipal Research of Rochester, N. Y., suggested the steps believed necessary in the preparation of a comprehensive street development program involving paving and repaving streets, extending sewers, water mains and other utilities and developing boulevard systems to provide convenient access to parks. The following is taken from his article.

Ways of Approaching Problem.—There are two ways in which this problem may be approached. The most obvious way and the way in which similar problems generally have been approached in the past, would be simply to list the streets in need of paving and repaving and to decide arbitrarily on the type of pavement surface to be provided in each case. The pavements then would be constructed according to general local practice, probably with a single standard of construction throughout and for all streets. Only the type of surface might vary from one street to another and that but little. The paving program would consist then only of this list of streets arranged in the tentative order in which the work would be done. Such a program would be simple to prepare, uneconomical to follow and inadequate to meet the needs of the city.

The preferred way of handling the problem would be to base the program on a scientific study of conditions to be met, to design each pavement as a structure suitable to serve economically the purpose for which it is intended, and to develop the street system not as chance has made it but as utility would direct.

Street System Most Important of City's Transportation Facilities.—Especially where motor trucking plays a particularly important part in handling both the incoming materials and the outgoing products of local industry, the street system should be developed to meet the needs of industry, as well as the general public, in the most suitable and economic way. Important factors to consider are the shortness of routes between local shipping points, and the ability of pavements built on such routes to stand up under the traffic conditions imposed upon them. Both factors may be subdivided, and both require careful scientific analysis and study.

It seems trite to state that the purpose of a street system is to provide ready means of transportation and communication between different points in the city, as well as entrance to the city from the surrounding country. But the layout of most street systems plainly indicates that little thought was given this purpose in the original platting of the streets. Moreover, the purpose includes, by inference at least, not only that the direction of the main streets shall be such as to provide the shortest possible routes between any two given points of importance, but that the routes so provided shall be passable and attractive to traffic. This means that layout and type of construction must be considered together.

In order that the purpose of the street system may be fulfilled it is essential that the points between which short, direct, passable routes are required shall be known. This information can be had in two ways. If the street system is to be laid out in undeveloped territory, as in a new city or town, the future location of important industrial, commercial and social centers can arbitrarily be decided upon in advance. But if the street system is to be developed to meet the needs of an older and well built up territory, the actual location of established industrial, commercial and social centers must be determined and the street system improved and developed in accordance therewith.

Importance of Direct Passable Routes Between Local Shipping Points.—To the business man the cost of local transportation by team or motor truck is a considerable item both for incoming materials and outgoing products. This cost of motor trucking will range from 10 to 15 ct. per ton-mile on well paved streets to 30 to 35 ct. per ton-mile on unpaved or poorly maintained streets. If long detours are necessary because of poor pavements or traffic congestion or lack of direct routes, the cost mounts in proportion. Drivers of motor trucks will go considerable distances out of their way to avoid [illegible] pavement [illegible]. Any delays caused [illegible] which the normal [illegible] directly affect the cost of transportation. Therefore [illegible] the [illegible] of convenience [illegible] industry to provide [illegible] routes between local shipping points.

The solution of this problem [illegible] of a system of main and intersecting thoroughfares [illegible] not always with present traffic [illegible] of what may be called [illegible]. Traffic [illegible] follow the shortest route [illegible] smoothly and [illegible] kept free from traffic obstructions [illegible] which occur on narrow, poorly designed [illegible] expense for snow removal in winter [illegible] and traffic will be more adequately cared for by concentrating attention upon a comparatively few main thoroughfares instead of attempting to keep all streets open at all times.

Zoning and Street Layout.—Another thought enters here and that is the importance of controlling the direction of the future industrial growth of a city. It is costly enough to design and construct a system of thoroughfares to meet existing conditions without contemplating the possibility of unregulated industrial building making necessary changes in the system within the next few years. A mile of asphalt pavement 30 ft. in width would cost, on a pre-war basis, about $59,000. No more of such pavements than are absolutely necessary should be built.

The existence of a well laid out street system will, in itself, tend to direct industrial growth as it should go, but it is wiser to provide governmental regulation of building (zoning restrictions) than to chance the future without such control. Hence the problem of zoning is closely related to the problem of street layout. Much the same physical data must be considered in both problems, and the fitness of the solution of each is dependent upon the other. Both must recognize not only the present location of industries but also peculiar advantages of site, such as convenience of rail and water transportation facilities, which will tend to attract future industrial development in certain directions.

In this connection it should be held in mind that the development of a system of main thoroughfares, including the widening, straightening and paving of existing streets, would greatly increase the value of property abutting on such thoroughfares. The increase in property value and utility would be enhanced still more by proper zoning and building regulation.

Elements Entering Into Street Design.—Without going deeply into details, it is believed that certain elements entering into street design should be held in mind in order that the relation between layout and design may be evident.

Almost anyone can "design" a pavement according to so-called "standards." Such "design," however, hardly warrants the naming. It is guess work, pure and simple, and is responsible for much unnecessary expenditure of money both in original construction and in continual maintenance. Highway engineering may not be an exact science, but at least it should approach the scientific. It is not scientific to build the same kind of pavement on residential, business and industrial streets, as is done in many cities. A pavement is not merely a wearing surface. The wearing surface takes the wear, wears out, and must be replaced.

If the pavement itself has been designed properly and constructed carefully, it should be possible to resurface it repeatedly without rebuilding the entire structure. Who would consider a bridge properly designed and built if the useful life were only the life of its floor.

Pavements must be designed in accordance with the traffic, or rather in accordance with the local weights they have to bear. Therefore, it is necessary to know these loads' weights, and they can be determined only through knowledge of the kind of vehicles and the weight of the loads to be hauled over the pavements. For purposes of structural design it is not so necessary to know the exact annual tonnage to be hauled over a pavement as it is to know the maximum live load weights to be hauled over it and the frequency with which such loads must be borne. The pavement should be designed for this maximum weight and intensity of traffic, to withstand impact and with an adequate factor of safety.

The width of a street also must be regulated according in the amount and kind of traffic to be borne. It frequently is found that some of the heaviest traffic streets are altogether too narrow for best utility. Moreover, some of these streets rightfully should not carry such heavy traffic because they do not provide the shortest and most direct routes between shipping points. This condition can be corrected by ascertaining the location of these shipping points and by laying out a system of heavy traffic thoroughfares to serve them.

It would be an ill-advised expenditure of money to pave or repave, or even to resurface, all streets now bearing heavy traffic with the idea that they will continue to carry it, without first studying their location in relation to local terminal points. It also would be ill-advised to improve streets which are too narrow for heavy traffic if they properly are main thoroughfares, without first widening the paved area sufficiently to carry that traffic easily and without congestion.

Another factor to be considered in designing pavement widths is the need for parking space for automobiles and other vehicles. It is believed, however, that the parking problem is partly one of police control. Proper design of the street system should provide parking space preferably in streets adjacent to main thoroughfares, and suitable ordinances and police control should ensure its proper use.

Control of Use of Streets. At this point it is desired to digress slightly from the subject of pavement design to emphasize the importance of proper regulatory laws and police control over the use of streets.

As stated in foregoing, a main thoroughfare must be designed for heavy load weights, for intensity of heavy traffic and for impact from heavy loads. It would not be economical to design and build all pavements within the city to withstand the effects of unusually heavy loads being hauled over them. The point may be made that if this is true, residential and other light traffic streets must be in danger of destruction whenever heavy loads of building materials, coal or machinery are hauled over them. To a certain extent this is true. If such streets were economically designed, with foundations of less thickness than the customary 6 in., etc., it would be more true. Hence, if a street system is to be designed and built economically, as few street systems have been, certain regulations governing the use of the streets are imperative. Loads weighing more than a specified maximum, made high enough to allow coal to be hauled to residences, should be restricted to streets designed for their use. Occasional loads of this kind should be routed by the street department; regular traffic should be required to use heavy traffic streets.

Moreover, attention is beginning to be given to the need for certain streets for slow moving and other parallel streets for fast moving traffic. This point should be given careful study in laying out and designing a street system. It may prove more economical to build two streets for different classes of traffic, than one street for both. If this is true, traffic regulations would have to be prepared and enforced to ensure proper usage of the street system in this respect also. Thus it seems that traffic regulations and street design are closely related.

Character of Pavement Surface. Other points that should be considered in designing streets are the character of the pavement surface itself and the location of subsurface structures. With the rapid increase in motor traffic, smoothness is becoming more than ever desirable in a pavement surface. The degree of smoothness has a direct effect upon the cost of transportation (because of the increase of tractive effort and of maintenance cost of vehicles and the necessarily reduced speeds of vehicles when operated on rough pavements), and the cost of cleaning and snow removal. In our northern states the latter is especially important. Streets must be kept open to traffic throughout the winter. Methods can be employed rapidly and economically to remove snow from smooth pavements, which cannot be used on rough pavements.

The less noticeable but equally important and more costly item of street cleaning which must be carried on through eight or nine months of the year can also be done much more effectively and at considerable less cost when the streets are well paved, smooth and properly maintained. These facts explain in part the tendency to use more bituminous surface pavements than formerly. Wherever this type of pavement is used, however, in a street carying heavy traffic economy demands that a specially designed foundation be built.

The location of substructures has an important bearing on the problem of street layout and design. It has been shown that a system of main thoroughfares paved with properly designed and constructed pavements would be an economic asset to any city. But if pavements are to be built to withstand extreme traffic conditions, they are bound to be costly. Therefore to allow public utility corporations and the city's water and sewer bureaus to cut into such pavements repeatedly is a practice that should be avoided if possible. Each pavement cut means a break in the foundation—the real pavement which cannot be repaired. There is no after construction factor which reduces the effective life of a pavement to a greater degree than pavement cuts. They can be avoided by placing all substructures in especially constructed galleries or elsewhere outside of the paved area of the street. This practice should be followed wherever expensive pavements are constructed.

The Economic Balance of 1920*

By K. LEE HYDER.

Considerable interest has been aroused throughout the office in an article written by Mr. Halbert P. Gillette in the April 7 issue of Engineering and Contracting. This article appeared under the following title: "Quantitative Analysis of All Factors That Affect Average Prices and a Formula for Predicting Price Changes."

The title itself is staggering in its apparent magnitude and creates immediate interest to the appraiser. The writer has studied this elaborate analysis with interest and attempted to digest and understand it, with more or less success. It would be beyond the scope of this review to give any details of Mr. Gillette's methods of arriving at his formula, but a short reference to his various factors will be sufficient and any one interested will or can go into this article at greater length.

By a very exhaustive series of steps Mr. Gillette shows that all factors affecting average prices may be analyzed and placed in a formula capable of giving accurate results, values of which factors are at all times available from reliable statistics.

Expressed verbally the formula he uses is: The wholesale index price for any given year varies directly with the total amount of currency in circulation and with the average number of times it is turned over annually, but it varies inversely with the total population and the per capital efficiency of production.

Expressing this as a mathematical formula, we have:

$$W = \frac{K \times M \times V}{P \times E}$$

W stands for the index price for any given year.

K stands for a constant quantity that depends upon the index price scale and upon the year selected as a base of 100 per cent for E. K is shown to equal ½

M stands for total money or "currency in circulation" in the U. S. as of July 1 of the given year.

V stands for relative rapidity of money turnover (or "velocity of circulation").

P stands for total population of the United States for the given year.

E stands for per capita productive efficiency. (By per capita efficiency is meant the ratio of total production to total population and has no direct bearing on the individual efficiency of the worker.)

Taking up these factors in turn, Mr. Gillette develops, by analytical methods, statistics from various sources and proves that they actually hold the relative place as given them in the formula. He finds for example, that the total quantity of money "M" in the country today is considerable in excess of the amount in 1913. This causes "W" to increase in direct proportion to the increase in money. He also deduces that "V," has rapidly increased in the last several years, again tending to increase "W."

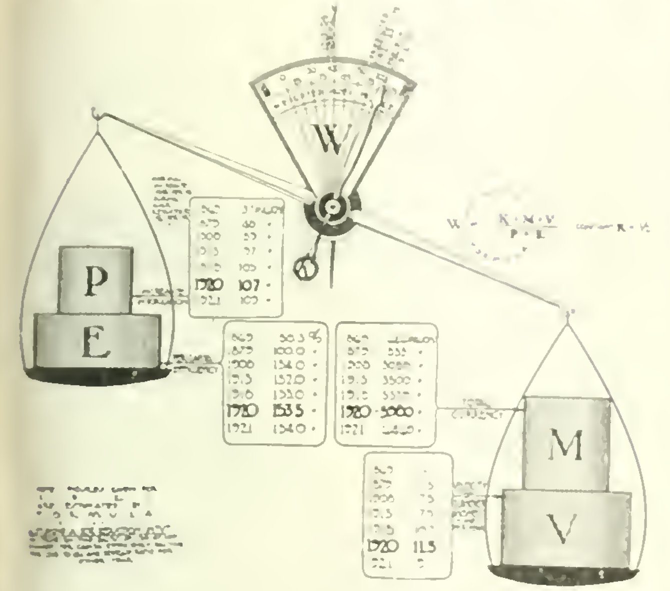
The factor "P" increases at a fairly uniform rate of 1½ per cent per year, causing a like reduction in "W." The factor "E," Mr. Gillette claims, has remained practically constant from [illegible] to 1920 but [illegible]. For example, Mr Gillette states that there has been no lowering of the per capita efficiency [illegible] the war, even though there may be a great drop [illegible] efficiency. This is accounted for largely by the [illegible] of a greater percentage of the population as [illegible].

---

*From the July "The American Appraisal News," a publication of the American Appraisal Club, Milwaukee.

To summarize the results that Mr [illegible] when applying his formula to present [illegible] we find that: first, there is no immediate prospect [illegible] reduction of "M" in fact we can expect about [illegible] increase [illegible] to the gold shipments from Europe [illegible] the latter part of the present year. [illegible] look forward to no more than the normal [illegible] increase in population, which in itself will have [illegible] bearing on the results for several years. Third, [illegible] expect very little increase in the factor "E." The [illegible] but the single factor "V" from which we [illegible] material decrease in prices.

Should it be possible to return to [illegible] conditions the factor "V" would only decrease approximately [illegible] per cent. It would then appear that in the next two or three years



The Economic Balance of 1920.

the most we can expect is a 20 per cent reduction in the index price, offset by an 8 per cent increase, due to increase of "M."

A study made of the conditions existing in all years from 1869 to 1920, and the formula worked out and checked against the actual index price existing at the respective dates, proved to check to a close percentage. "The formula as a formula seems to work." But as is often the case figures may be made to do almost anything by a clever statistician. It is, however, in itself a most interesting addition to economical science.

The application of this formula to our own or any other individual business would probably be of doubtful value. We could not, for instance, determine [illegible] the trend of construction costs of any individual item or of all costs in one location; the weighted index price of all commodities for the entire country being the only result that Mr Gillette attempts to obtain.

Also to predict any great distance in the future on the assumptions would be of doubtful accuracy, owing to the extreme difficulty to foretell economic conditions, particularly in regard to the rate of turnover of [illegible]. There is no doubt that some check could be kept [illegible] in advance as to what the next few months might foretell, but this rate of turnover depends largely upon policies of the financial interests who so largely direct the credit and hence the production and sale of commodities.

It is quite possible, however, that if this formula has any real value outside of a statistical one, it would be in a business such as ours where we depend not on any one line of production, but draw largely from all lines and throughout all sections of the country. Our business should be one endeavor where the results could be applied to practical advantage, but this in a general manner only.

It is conceivable that results determined [illegible] this manner could be used [illegible] buying [illegible] period of expansion [illegible] business conditions.

In reviewing [illegible] it [illegible] to be a [illegible] after [illegible] factors of price [illegible]. [illegible] students of the problem have [illegible] factors to their consideration which Mr [illegible] not consider, among which are the present [illegible] the high wage scale and the low [illegible] efficiency.

Mr L. W. Alwyn Schmidt, [illegible] in a recent article states that the [illegible] prices have practically reached the crest and we may look for an [illegible] and gradual lowering. He also calls attention to the expected arrival of European gold with the resulting [illegible] of foreign exchange and states that this will help the trading [illegible] and thus help to solve the international price problems. (This is in exact antithesis to Mr Gillette, who claims this will only serve to increase prices as long as the unbalanced condition of the money market remains.)

He also takes a more practical viewpoint in stating that the average consumer is beginning to refuse to pay the prices asked and they in turn must come to the level which he is willing to pay. He expects just enough loss to industries to allow a certain amount of idle labor, which will reduce wages a trifle, but only enough to benefit the wage earner as a consumer and not enough to injure him as a producer.

Mr Gillette states that the scarcity of commodities in Europe affect the average prices of America in three ways, first, shipment of gold to America; second, by increasing the rate of money turnover; third, the reduction of normal quantity of commodities available for American consumption. In this sense then he agrees with Mr Alwyn Schmidt quoted above.

The Chicago Tribune has been conducting a series of articles written by the "Inquiring Reporter." They have found the general opinion to be that profiteering has caused the high prices. In offsetting this statement the argument made by Mr Gillette is that profiteering and extravagance merely serve to divert money income, but do not alter its total as far as the index price is concerned.

Another viewpoint is that of Mr F. A. Vanderlip, former president of the National Bank, New York, who says that the financial machinery of the country was supported during the war by the Federal Reserve's banking system, that under this act the banks were allowed deposits 30 times greater than their reserves, while under the old banking act deposits averaged only seven times greater than the reserves. This caused a rapid expansion of credit and since currency and credit was available more commodities could be purchased, but as there had been an insufficient amount of these commodities after the war, the price immediately rose.

The fact that Mr Gillette places his conclusions on record in a straightforward, clean-cut, scientifically conceived article covering every factor brought forward by others and disposing of them in proper sequence, is, however, sufficient in itself to warrant a feeling of confidence in the results obtained.

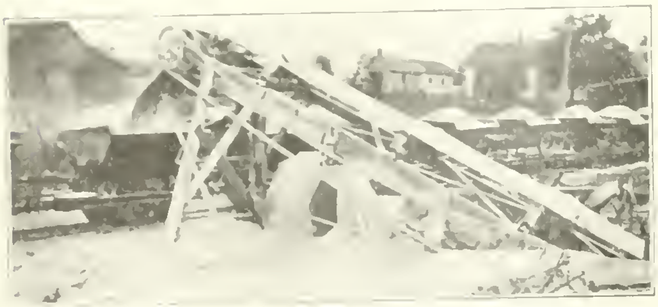
An interesting chapter in this article is devoted to the Construction Industries. Mr Gillette parallels the period following the Civil War with the present time and shows that during such times commodities used in construction are the last to rise and also the last to fall. When the new level is established the index price gradually adjusts itself to a new weighted standard. He predicts a decrease of about 20 per cent on most commodities, but as construction has not risen to the level of other commodities, it is quite possible no reduction will come, at least not for a long time.

As a whole this is undoubtedly a brilliant treatise in the study of economics and will be another forward step in the pathway of science.

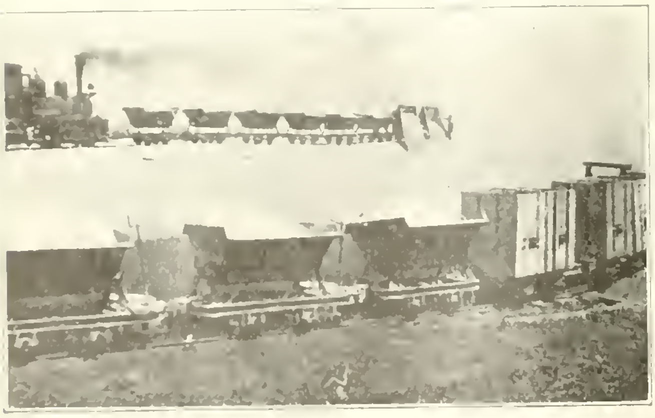
New State Highway Commission of New Jersey.—Three of the seven members of the new State Highway Commission of New Jersey, announced by Governor Edwards on June 30, are engineers. One member is a contractor, one a business man, one a lawyer, and one a retired dealer in automobiles.

Rehandling Stone from Hopper Cars to Industrial Cars

A belt conveyor loading directly into small V-shaped dump cars is employed on a concrete road job near Coatesville, Ind., for handling broken stone from standard gage railroad hopper cars. The hopper cars discharge into a pit, from which the material is reloaded directly by the belt conveyor into the dump cars, which carry it to a storage pile 5 miles away. The train is hauled by a small steam locomotive. Two such trains are operated. On account of the heavy grades it is necessary to "run" for some of the hills, and to go up another in two sections. The train climbs to the top of the stock pile, where the cars are dumped. A stiff legged crane lifts sand and stone as needed into a small bin from which the batch box trains are loaded by gravity. This method of handling aggregate is being used on Federal Aid Project No. 4, comprising 8 miles of concrete highway, for which the Cunningham Construction Co. is the contractor. The work is described in the August Earth Mover, from which the above note is taken.



Belt Conveyor Rehandling Stone Dumped From Hopper Cars Into V-Shaped Dump Cars.



Unloading Crushed Stone at Stock iPle. Loaded Cars in Foreground Are Part of Divided Train Waiting to be Dumped.

Large Loading Bins for Concrete Road Job

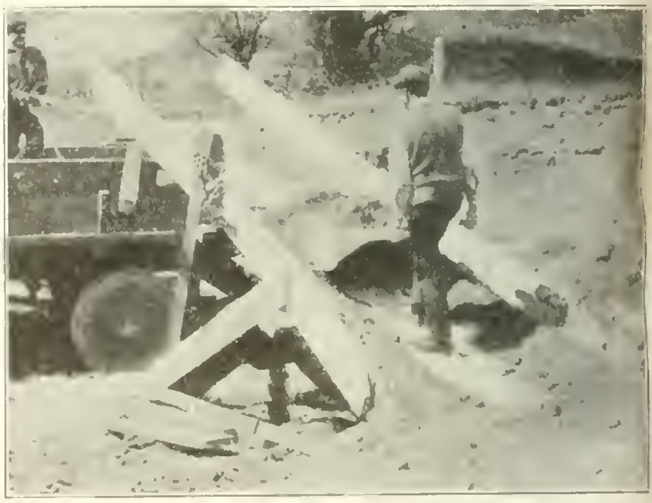
Large portable bins erected in three permanent sections, each of which can be transported on a railroad flat car, are employed as a loading station for the concrete road job of James O. Heyworth at Marshall, Ill. Material is received in standard gage cars and is unloaded by crane and clamshell bucket into the bins or into stock piles. The unloading of a car in this way takes 10 minutes. An industrial railway passes under the bins, with switches outside to enable the locomotive to take on oil and gasoline without delaying the work. A train of empty batch boxes is backed under the bins for loading by gravity, 10 boxes at a time. Each batch box has a capacity of 57 cu. ft. Inside each box is a compartment holding 2 bbl. of cement.

Most of the cement is received in bulk and unloaded into the central bin. Occasionally, however, it comes in sacks, and to handle these a platform and chute has been rigged up at one end of the bins as shown in the accompanying illustration.

The Heyworth contract, covering a 20-mile section of the National Highway in Illinois, is described in the August Earth Mover, to which we are indebted for the above information.

Gravel Loading Device

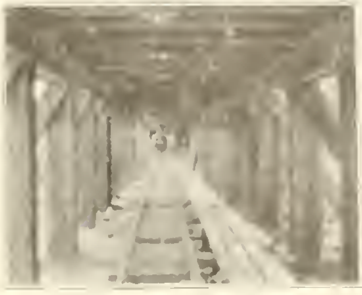
A simple and economical arrangement developed by O. M. Briley is used in loading gravel on trucks for maintenance work on the roads at Iowa State College. While the trucks are away unloading, a team attached to a wheel scraper is used to strip the gravel and have a supply ready in front of the chute shown in the picture, which is reproduced from the Service Bulletin of the Iowa Highway Commission. When the trucks stop in front of the chute a cable is attached to the wheeled scraper and the team and scraper provide the motive power and equipment for scooping the gravel up the chute and into the truck.



Gravel Loading Arrangement at Pit.

Obituaries

Harry A. McLaughlin, eastern sales manager for the Thew Automatic Shovel Co., with offices at 30 Church St., New York, was killed Monday evening, Aug. 23d, and three companions seriously injured when his automobile overturned near Summit, N. J. Mr. McLaughlin formerly represented the Buffalo Roller Co. at Albany, N. Y., and was well known among contractors throughout the country.



Under the Bins.

Material Bins.

Loading Sack Cement.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.
Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., SEPTEMBER 8, 1920. Number 10.

What Books on Economics Shall I Read?

This query comes to us so frequently that it seems desirable to give an editorial answer. There are three broad economic fields: (1) Political economics, (2) business economics and (3) engineering economics. These three overlap to a great extent, and whatever the three fields have in common may be designated as being general economics. General economics might properly be called economics, omitting the adjective general, and it would be so called were it not for the unfortunate practice of using the word economics as a synonym for political economics.

In a recent paper on "Teaching Elementary (Political) Economics to Engineering Students," William M. M. Duffus, Associate Professor of Economics, University of Kansas, said:

> The writer has used Ely's "Outlines of Economics" as the text this year and has assigned additional readings in Marshall, W[illegible] and Field's "Materials for the Study of Elementary Economics." Such collections of illustrative material as are found in Marshall's "Readings in Industrial Society," Hamilton's "Current Economic Problems" and some of the more specialized books of readings might well be used as additional references. The writer has found it inadvisable to depend upon any one book or [illegible].

We agree with Prof. Duffus in advising students not to depend upon any one book. Beginning with Prof. Ely's "Outlines of Economics," which is a text book on political economy, the student of the subject, many next take up Prof. Taussig's two-volume treatise on the same subject, entitled "Principles of Economics." Then read the classical work by John Stuart Mill, "Principles of Political Economy."

The editor found it profitable to read also "The Wealth of Nations," by Adam Smith. This was a pioneer treatise on political economics, published in 1776. Many reprints are available.

To an engineer it will be surprising to find how few are the quantitative data given in general treatises on political economics. Engineering economics is essentially a quantitative science, and its principles are usually illustrated by quantitative problems. Indeed, many of the principles are themselves expressed as formulas. But books on political economics are, as a class, distinctly non-quantitative as to nearly all their text. This, it seems to us, is indicative of the reason why so much that has been written on political economics is a matter of dispute. Take, for example, such a question as government ownership of public utilities, and note carefully the treatment that it receives at the hands of political economists. You will find pro and con arguments, mostly deductions from assumed premises, but for quantitative data showing the relative economy of private and public ownership you will usually look in vain. By contrast, consider what you would think of an engineering treatise in which the author would use the following argument: When the span of a highway bridge is less than 100 ft. a concrete arch is the most economic type, as may be easily shown. In spans of less than 100 ft. a steel truss bridge is objectionable because of its relatively short life, as compared with concrete. Moreover, a concrete arch is far more pleasing in effect than a steel truss bridge. Finally, the earliest forms of short-span bridges were made of masonry, which shows the instinctive or natural preference of man for more durable materials and graceful lines.

The only economic argument in this hypothetical reasoning about bridges is the one that alleges a longer life for concrete than for steel, but in the absence of any data as to their relative lives no conclusion can be drawn as to their relative economy. In a parallel manner, the absence of quantitative data relative to municipal ownership, for example, makes it impossible to draw conclusions from the statements that characterize the ordinary discussions of the subject in books on political economy. Nevertheless, weak as such books are, they do contain some information that every engineer should know.

Of books devoted entirely to the principles of engineering economics, there are relatively few. Prof. Fish's "Engineering Economics" is one that may be studied with profit. Prof. Humphrey's "Lecture Notes on Business Engineering" is perhaps less a book on engineering economics than on business economics. The first two chapters of the Handbook of Mechanical and Electrical Cost Data, by Gillette and Dana, would make a fair sized book on the principles of engineering economics, and in the chapters that follow are many applications of the principles of economics. For example, the problems of designing the most economic size of pipe through which to pump water, the most economic size of penstock, and the most economic size of electric conductor, are solved in a perfectly general manner.

Prof. Goldman informs us that his publishers, John Wiley & Son, are about to produce a book by him entitled "Financial Engineering."

Of books on business economics, there are hundreds. Hatzfield's "Modern Accounting," Gillette and Dana's Cost Keeping and Management Engineering, Secrists' "Introduction to Statistical Methods," Hollingsworth's "Advertising and Selling," Cooper's Financing an Enterprise," Babson's "Elements of Successful Investing in Bonds and Stocks,' will serve to open the door to a knowledge of business economics. There is a book devoted entirely to books on business economics, namely, "Sixteen Hundred Business Books," by Bell. In Engineering and Contracting, June 11, 1919, a list of 370 "selected business books was given.

As part of any serious effort to become well founded in economics, every engineer should take a thorough course in bookkeeping. A correspondence course or a night school course is to be advised. A young engineer would do well to follow such a course by securing employment as a bookkeeper in the office of a public utility company for six months longer, until thoroughly habituated to think in double entry and able to handle figures with precision.

Accounting and cost analysis are at the basis of economics. Hence the great importance not merely of understanding the principles thereof but of being trained in the application of those principles. The weakness of most courses of study of economics is mainly attributable to insufficient training in the application of the principles in the solution of given problems. In fact, few of the problems that authors of books on political economics attempt to solve are really solved. This failure to arrive at a demonstrable conclusion may be traced to lack of training in solving simpler economic problems, such, for example, as are involved in selecting the most economic pump for a given service, or the most economic location of a railway for a given traffic, or the most economic location for a retail store in a given city, and the like. Untrained in the method of securing quantitative data, of analyzing the data, and of drawing definite conclusions therefrom, the average author of a book on political economics attempts to solve the most complex of problems in social economics, and almost inevitably fails to go about his task in a scientific manner. In consequence of the general worthlessness of most of the writings of professed political economists, there exists in this field of economics a wonderful opportunity for engineers. The usual quantitative training of the engineer is an admirable training, as far as it goes, but it must be accompanied or followed by a training in political and business economics, and in logic, before an engineer can successfully undertake to do his part in making political economics an exact science.

Estimating City Population by Applying a Factor to Water Service Connections

One of the commonest ways of estimating the population of a city is to apply a factor to the number of school children. Another method is to apply a factor to the number of names in the city directory. A less common method, but one that is worthy of consideration, consists in applying a factor to the number of water service connections.

School census data are often very unreliable, and the same holds true as to the completeness of city directories, but the number of active service connections is usually known with great accuracy. The only question that then arises is as to the reliability of the factor used in multiplying the number of services.

The censuses of 1890, 1900 and 1910 for the city of Cleveland, Ohio, indicated 8.1 persons per service connection, but the census of 1920 indicates about 7.1. Is the census of 1920 in error, or is the old factor of 8.1 inapplicable? It is more probable that the factor has changed than that the census is in error.

Cities in which a large percentage of the population live in apartment houses have a higher factor than those in which most of the people live in separate residences. Having this in mind, it would be desirable to segregate the service connections into three classes: (1) Commercial services, (2) Apartment houso services, and (3) Separate residence services. Then by applying an apartment house factor to the number of apartment house services, and another factor to the number of separate residence house services, it would be practicable to estimate the population of a city with much greater accuracy.

How to Secure Smokeless Cities

Relatively few large cities are smokeless in the winter, and those few have ordinances compelling the use of anthracite. In spite of all that has been done to reduce the quantity of smoke given off by bituminous coal, the large northern cities in which its use is permitted are all sooty and grimy during at least half the year.

If all locomotives and power plants operating in cities were required to burn powdered coal, a large part of the smoke nuisance would disappear, but there would still remain a vast volume of smoke from coal used in heating buildings. The only practical way of eliminating smoke from office and residence buildings appears to involve some sort of treatment of the coal prior to its use in furnaces. Judging from a paper recently read by George Esherick, Jr., before the Kentucky Mining Institute, a commercial process has at last been developed for taking the smoke out of any kind of soft coal. We quote:

> The conversion of bituminous coal in commercial quantities into a fuel resembling anthracite is an attractive problem from many angles. The requirements of such a fuel are primarily that it be smokeless, easily burned, but not too expensive. It should be as uniform in size as possible, have a reasonably high heat value, be easy to handle and safe to store.
>
> The Smith process aims to accomplish the needs outlined by producing a smokeless fuel as good as or better in quality than anthracite, and one that can be sold at a price that will insure its general use. The name "carbocoal" has been given to the fuel secured.
>
> The method of its production is briefly as follows: Raw coal as it comes from the mine is crushed and fed continuously into low-temperature horizontal retorts by means of paddles. The volatile products of carbonization, i. e., the tar, gas and ammoniacal liquor, are treated essentially as in coke-oven practice. The semi-coke which is continuously discharged from each retort is quite different from ordinary coke. It is much softer, carries 8 to 10 per cent of volatile matter and burns readily. It could be used directly in a power plant, either as fuel under the boilers or in gas producers, but is not in condition to market for general use.
>
> In the next step of the process this semi-coke, or semi-carbocoal, is ground, mixed with pitch, fluxed and passed through a briquet press. The raw briquets are then carried to inclined retorts and distilled again at a temperature of about 1.800 deg. F. for six hours. They are then dumped and quenched. The tar, gas and ammoniacal liquor from this high-temperature carbonization are collected and treated along with similar products from the low-temperature carbonization.
>
> The main product of the Smith process is, of course, the carbocoal, which represents about 70 per cent of the weight of the material treated. This fuel as it comes from the high-temperature retorts is in the form of hard briquets of a density much greater than that of ordinary coke and only slightly less than that of coal.
>
> As a domestic fuel carbocoal compares favorably with anthracite. It has a heat value of about 13,000 B.t.u. (assuming a coal with 7 per cent of ash, as above). Being of uniform size and quality, the productb urns evenly in the fire bed, leaving under proper firing conditions a clean, light ash. In all cases the tendency to clinker is much less than with the coal from which the carbocoal is made. There is no difficulty in banking the fire and it responds readily to draft control.
>
> Carbocoal has been tested under stationary boilers with excellent results. In one test at the plant of the Fosdick Machine Tool Works, Cincinnati, Ohio, carbocoal gave an evaporative efficiency of 58 per cent and a combustion rate of 23 pounds per square foot of grate surface. This was on a 103-hp. horizontal return-tubular boiler operating at 116 per cent of rated capacity. In a similar test made with coal on the same boiler and under like conditions an evaporative efficiency of 45.2 per cent was found, with a combustion rate of 22.7 pounds per square foot of grate area, under a load of 97 per cent of boiler rating. During the carbocoal test there was no smoke from the stack, while during the coal test, as is usual, a large volume of smoke was discharged.
>
> The higher efficiency of the carbocoal does not lie in a greater

B.t.u. value is the [illegible] a little less than that of a high-volatile coal. It arises from the fact that practically all the carbon in the [illegible] there is no smoke and little [illegible] On the other hand, smoke losses have to be [illegible] if that appreciable amount of [illegible]

Mr. Esherick states that the ammonium [illegible] plate and oils derived from the treatment of coal [illegible] Smith process have a high market value, and that the pitch derived is approximately the amount required [illegible] the semi coke.

Relatively few mines yield coal [illegible] good coke, whereas any bituminous coal can be successfully treated by the Smith process. Hence it seems probable that this new process may eventually enable every [illegible] city to rid itself of the sooty clouds that envelop [illegible] figure it.

Book Review

Drainage Engineering. By Daniel W[illegible] M[illegible], A. B., A. M., Ph. D., Consulting Engineering M. A. [illegible] E., Former Drainage Engineer, U. S. Reclamation Service. McGraw-Hill Book Co., Inc., New York and London. [illegible] in., pp. 178, illustrated. $2.50.

This volume is a general treatise on the drainage of agricultural lands written in a semi-popular style rather than a technical one. The first chapters are devoted to a discussion of soils, their formation and composition, to the growth of plants, and the water conditions most favorable to their growth, and to water supply. The author then takes up in detail the subject of drainage. Natural and artificial drainage, and such factors as surface and sub-surface drains, with their effect on soils, and the benefits of drainage are considered.

The chapters which follow discuss fully the practical aspects of drainage, and are especially valuable as the author writes from personal experience. He devotes some space to instructions as to drainage investigations, and goes on to a discussion of location and depth of drains, and their capacities under various conditions.

Another section, fully illustrated by charts and photographs, considers drainage constructions. The relative merits of open and closed drains are brought out, and the author takes up generously methods of excavation in various kinds of soil, and all of the problems relating to piping, etc. The book closes with a practical consideration of the economic questions involved which determine the feasibility of drainage.

The book is clearly written, shows a first hand knowledge of the material treated, and is especially valuable because of its application to irrigation problems.

"What an Annual Report of a City Should Contain"

To the Editor: The article in Engineering and Contracting for Aug. 11 on "What an Annual Report of the City Should Contain" embodies excellent suggestions to carry out a very much needed advance in recording the great amount of municipal work that is being done in our country.

It should certainly be "readable," be written in a good "style and form," contain "pictures" and be well "circulated" in the community. Such a document is one of the best opportunities of "advertising" the city, and establishes a mild competition, resulting in an increase both of improvements and economics.

One heading, however, has, I should say, been omitted, which the writer believes is quite important, as it would be quite helpful in drawing comparisons as to expenditures and efficiencies. That heading refers to Cost. City engineers have a good opportunity of presenting the unit costs of the work in their charge, both with and without the usual fixed charges of interest on the investment, supervision, etc.

The objection that the local conditions greatly affect the cost and therefore that comparisons are not fair, falls if the influencing local conditions are stated. They make the report even more valuable.

It would be still better if the engineer can add a reduction of his cost items to efficiency items, by excluding wages but including the time element. In other words, it would be well to give also the man-hours for different classes of work, the ton-miles per hour for hauling by different means, foot-pounds per hour, gallons lifted per foot per hour, etc.

Such information is [illegible] and indicates efficiency in [illegible] machinery and labor. Furthermore, it [illegible] to be made with other countries [illegible] In Europe [illegible] reductions are quite common. [illegible] only by the local engineers in charge of the work.

RUDOLPH HERING,
Consulting Engineer.

Montclair, N. J.

Ordinances Relating to Discharge of Solid Matter Into Sanitary Sewers

To the Editor: At different times during the past few years, the writer has had his attention called to the discharge of solid matter of different kinds into the sanitary sewers of this city.

Laundry water discharged into the sewers has had the temperature of such discharge cooled sufficiently to cause a deposit to take place on the inside of the sewer pipes, reducing their capacity. A similar condition has been found where the restaurants have discharged water containing grease. It was thought that such deposits from both laundries and restaurants could be prevented if the discharge from such plants were carried through chambers, which would be of sufficient size to permit the water to be cooled before disposal into the sewers. Furthermore, the disposal of solid matter from canneries for fruit, vegetables and fish have caused trouble in maintaining the sewerage system.

At the present time this city has an ordinance which prohibits the deposit of any solid substance in its public sewers, although the prosecuting attorney of the city has advised that he cannot prevent the abuse when the water discharged therein may contain in solution solid matter which will deposit when cooled. What is desired is an ordinance which will prevent such abuse and use of the sewerage system, and the writer is accordingly requesting that you advise him if you have any knowledge of cities where ordinances are in use which would prevent the abuse above mentioned. At the present time the writer is planning to have such an ordinance proposed for adoption which it is hoped will be effective in correcting the troubles above mentioned. Meanwhile such data as you might furnish him could be employed to advantage in the ordinance proposed for this city.

W. T. KNOWLTON,
Engineer of Sewers.

Los Angeles, Calif.

Engineers "Safety-Valve Club"

To the Editor: Are not engineers as a whole greatly deficient in the power of audible expression? Certain members of the American Association of Engineers in Chicago believe this to be true and have launched a unique means of meeting this deficiency.

The Safety-Valve Club—"bunch" would perhaps be a more suitable term—assembles twice during the month for discussion of problems in general: economics, ethics, politics, finance, engineering, in fact any subject of interest.

The club maintains no membership lists, levies no dues, enforces no rules and boasts of but one officer—the chairman—who is elected at each meeting. This bohemian organization has demonstrated its usefulness not only to the Chicago Chapter, A. A. E., in bringing out the high lights on some problems which have come before it but also in the valuable experience which each participant gains in meeting his fellow engineer in oral battle.

On one occasion when the proposed adoption of the metric system was under discussion, the air at first seemed filled with opposition, but as the opponents of this measure failed to back up their statements with any real data the minority finally won most of them to their side. This incident displays a fault all too common with engineers, that of making rash statements having no foundation other than a tricky human opinion based on tradition, hearsay or biased news items.

On another occasion a debate was staged with two members as leaders. The leader of the affirmative side failed to appear, because as he announced later, he could not conscientiously talk on that side since his investigation had shown him that the other side was in the right. However, the negative leader whose conscience was not quite so troublesome took the affirmative, a leader was found for the negative and the debate progressed as if nothing had occurred.

A feature of the meetings after the problem of the evening has been thoroughly dissected is the friendly criticism of each other's delivery, mannerisms or attitude if these show very marked defects.

That engineers are educated technically beyond their business ability to present this technical knowledge to others cannot be denied. If there were only more "Safety-Valve" Clubs where engineers might develop this ability there would be greater progress in engineering.

The "Safety-Valve" in Chicago blows off spontaneously each fortnight and any engineer would profit by attending one of these explosions.

Chicago, Ill. ROBERT W. SHELMIRE.

An Inconsistent Pronouncement of the American Federation of Labor

In refusing to endorse the Russian soviet form of government because soviet rule does not exist by the will of the Russian people or even of the class which it is supposed to make supreme, the American Federation of Labor acted from the point of view of unadulterated Americanism. But in favoring political action that would put into our public offices and our legislative halls men "favorable to union labor" the Federation was inconsistent with the former point of view.

Any man who seeks public place in this country on a platform that promises to favor any class or any interest less than the national interest, is not standing on an American platform, and any one who votes for him because of his restricted platform, votes against the best interests of the whole people.

A "Labor party"—and that means, in the view of the Federation, a Union Labor party or concerted action aiming to seek advantage for any class or group of labor, if successful no more would represent the will of the American people than does soviet rule in Russia represent the will of the Russian people.

There is one principle, and one only, in the government of a republic, in genuine democracy, and that principle is the rule of the majority of all the people qualified under the Constitution to govern the republic. When any class or interest, by legitimate means, can secure a majority for what it advocates, then it is acting democratically and properly. But unless it can secure this majority by persuading the bulk of the people that what it advocates is for the good of the nation at large and not for the good of a small fraction of the nation, then it is not acting according to the principles of democracy.

We have quite enough laws now on our statute books that were framed to favor some class or some interest. What we need is a national housecleaning that will repeal all of these narrow and selfish and un-American laws and give us laws framed only for the general good and favoring no class or no special interest. This is democratic government, this is Americanism. And this is what every American citizen should work for and fight for, if need be.—Editorial in the August Valve World.

Operating Factors of Water Department of Holland, Mich.

The operating factors of the water works of the city of Holland, Mich., for the past year are summarized as follows in the annual report of the Board of Public Works for the fiscal year ending March 15, 1920:

Population (estimated)	12,500
Number of consumers per 100 of population	21.04
Station capacity in million gallons per 24 hours	7.5
Station capacity per employe, million gal. per 24 hours	.68
Station capacity per capita, gallons per 24 hours	600.
Average amount of water pumped per day ... gal.	912,288.
Average amount of water pumped per day per service ... gal.	346.
Average amount of water pumped per day per capita ... gal	72.89
Maximum amount of water pumped in one day ... gal.	2,336,800.
Minimum amount of water pumped in one day ... gal.	109,053.
Number of fires	89.
Investment per 100 gal. capacity	$ 3.32
Investment per capita	19.91
Total operating revenue per 100 gal. capacity	5.67
Total operating revenue per capita	3.41
Total operating revenue per $100 invested	17.11
Net income per $100 invested	3.85
Ratio of total operating expenses to total operating revenues ... per cent	74.54

Method of Transporting 70-Ton Rotors Through Mountainous Country

By WAYNE A. S. HARMON.
Mechanical Engineer, Los Angeles, Calif.

In building the latest addition to its hydraulic resources a 35,000 KVA plant, the city of Los Angeles had to transport two 70-ton Rotors 10½ miles through mountainous country. The road lies entirely in the mountains and contains many long, steep grades having short radius curves and deep, narrow cuts. In places the road is merely a bench blasted out of solid rock containing several right angle turns and in other places it lies for several miles in a dry river bed.

The rotor, field pieces removed, was 8 ft. 5 in. diameter by 5 ft. 5 in. wide. The shaft, overall, was 17 ft. 8½ in. long, 16 in. diameter on one side of rotor and 14 in. diameter on the other. It was shipped supported by its shaft in a cradle.

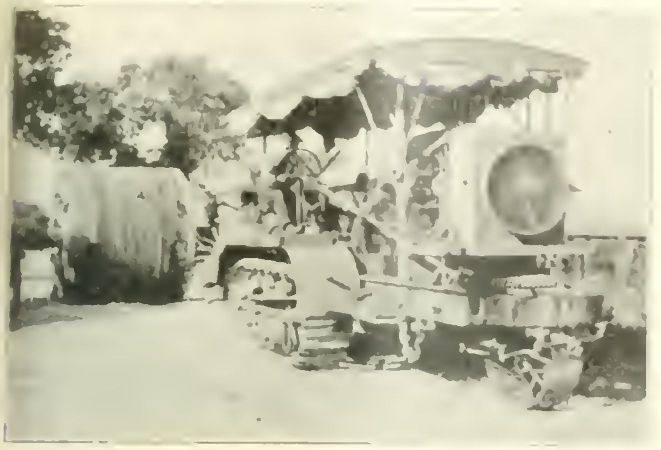
Ready to Run Off a New Hitch.

We placed timbers under the shaft and jacked it up to the required height and removed the cradle and started the carpenters to work lagging it with 8 in. x 8 in. x 8 ft. long timbers. These 8-in. x 8-in. timbers were beveled at the mill to fit exactly so that no fitting up had to be done on the job. The overhanging ends of the lagging timbers were supported by two 12-in. wide felloes, one on either side of the rotor. Each felloe consisted of two 6-in. wide by 12-in. deep felloes that broke joints and were firmly bolted together and then bolted to the lagging. Spokes were run from one side of felloe to the other, not touching the rotor shaft.

Outside the lagging and directly over each felloe were placed ½-in. by 6-in. steel hoops split in half with turnbuckles and between these were four intermediate ½-in. by 4-in. steel hoops with turnbuckles. These turnbuckles were countersunk into the lagging so as to offer no obstruction to the cables we were to use in rolling the rotor. The shaft on either side of the rotor was lagged with hardwood held in place by steel clamps. All wood used with the exception of the shaft lagging was Clear No. 1 Oregon pine.

In rolling the rotor many methods were taken under consideration, but finally the rolling hitch was decided on. When it is taken into consideration that the outside diameter of the lagging was 9 ft. 8 in. it will be seen that the rolling hitch gave a large leverage with which to easily handle it on the steep grades and deep sand. Also there was no liability of injuring the bearing faces on the shaft; this was considered of great importance. Had we pulled from the shaft through auxiliary bearings we should have had to keep out of alkali dust of which there was an abundance.

The method employed in using the rolling hitch was as follows: Two cables, each 750 ft. long, were used with loops in each end. The middle of the first cable was fastened to an eye-bolt and chain bolted through the lagging on the center line of the rotor; then each half of the cable was wound around and around the lagging away from the center line of rotor until they reached the opposite ends of the lagging and there were secured by additional eye-bolts and clevises. By unloosening the cable from the center eye bolt and attaching it to a caterpill[illegible] the rotor could be rolled and after the first revolution of the rotor it was stopped and the middle of the second cable was attached to the middle eye bolt. As the first cable was being unrolled by the caterpillar two men [illegible] cable on. When the end of the first cable was reached its ends were disconnected from the outside eyebolts and its center from the caterpillar. The cable was [illegible] back by a team and its center attached to the [illegible] eye bolt of the lagging. The caterpillar was backed up and hooked onto the middle of the second cable, which was now wound around the lagging, and the operation repeated.


Starting Off a New Hitch.

To steer the rotor two $\frac{5}{8}$-in. cable slings and another caterpillar was used. This caterpillar was kept behind the rotor and a sling thrown over either end of the lagged shaft. Thus by holding back on either sling, while the rotor was revolving, it could be turned in a 20-ft. radius. Where right angle turns were necessary the rotor was rolled up on two 4-in. x 12-in. planks and balanced. In this manner it could almost be spun like a top. At one place we had it up thus and it refused to be budged, but by throwing a few pails of water on the planks the results were surprising.

We experienced considerable anxiety as to how it would behave in the loose dry, sand, for when it rolled over 4-in x 12-in. plank on apparently very hard road it would push them level to the road surface and curl them up like a collar. We had about 3 miles of this dry river wash to negotiate and were agreeably surprised to see how easily it rolled in the very finest loose sand. We made our best mileage there.

Cutting Around a 25-Ft. Radius Curve (Note—One Steel Hoop Gone from Lagging).

In going around a lake on about a 100-ft. radius we encountered considerable difficulty. On the lake side of the road it sloped abruptly into the lake and on the other side was a perpendicular bank with large rock outcroppings. The road was too narrow to maneuver the rotor around these rocks and so timbers were laid on the road and were built up until the rotor shaft would pass over them.

Our rolling [illegible] saved [illegible] for [illegible] more than once. At one place we were passing [illegible] bridge when the bridge stringers and abutments gave [illegible]. The front caterpillar maintained its tension on the rolling lagging to prevent the rotor from rolling back into the [illegible]. The rear caterpillar was put through the [illegible] and hooked onto the front one and the rotor rolled out. In the meantime while all this caterpillar changing was going on the abutments could be seen to be sinking and the timbers were popping.

This bridge had been cribbed up almost solid and the stringers were of 10-in. x 10-in. solid but the heavy concentration of loading pushed the cribbing into the stream bed and the stringers were sheared off like matches.

The total equipment consisted of two 75 HP. Holt caterpillars, two 750-ft. lengths of $\frac{7}{8}$-in. cable, six snatch blocks, one 3-ton supply truck, one 4-ton tank truck, two caterpillar drivers, one mechanic, two truck drivers, one teamster, eight laborers, one foreman and the writer.

The tank truck was used to haul water to soak the lagging at night time, care being used to see that the shaft was properly oiled to prevent rusting. About 200 gal of water were used each night as we were traversing a semi-desert country.

The plant is in successful operation now and another hydro-electric project is being designed and will soon be under construction. The work is being done under the direction of Chief Electrical Engineer Edgar Scattergood and Assistant Electrical Engineer H. C. Gardett. The writer is attached to the engineering staff.

Standardization of Waterworks Corporation Cocks

Three different kinds of corporation cocks for water works should be sufficient, stated Adolph Mueller, president, H. Mueller Mfg. Co., in a paper read before the recent Montreal Convention of the American Water Works Association. About the only difference in the three kinds is in the threads. The three different kinds of threads are required for those inserted with a tapping machine, those for iron pipes, and, thirdly, those for wood mains.

At present, according to the paper, it takes 332 styles and sizes of corporation cocks to meet the needs of 128 cities where three styles would answer. To keep patterns and dies for all of these on hand when some of them are used only once or twice a year unnecessarily increases the overhead expenses of manufacturing. The following suggestions have been made regarding standardization of corporation cocks:

Make all corporation cocks with flat sides, eliminating all round bodies or other shapes.

Eliminate squares and hex on all our cocks except on $1\frac{1}{4}$ in., $1\frac{1}{2}$ in. and 2 in. sizes.

Eliminate $\frac{3}{4}$ in. sizes.

Eliminate female thread corporation cocks.

Three kinds of threads as previously mentioned.

The openings on iron pipe threaded corporation cocks shall be reduced in the smaller sizes, making $\frac{1}{2}$ in I. P. threaded cocks with $\frac{3}{8}$ in. opening, $\frac{5}{8}$ in. with $\frac{1}{2}$ in. opening, $\frac{3}{4}$ in. with $\frac{5}{8}$ in opening and 1 in. with $\frac{7}{8}$ in. opening. The reason for reducing the opening in I. P. threaded cocks is because it is more practicable for manufacturing and allows more metal, making a stronger cock.

Cocks inserted with machines and wood main cocks to have full bore or openings.

The couplings or outlet end of all corporation cocks to have standard I. P. threads one size larger than body.

All couplings to be standard as to length and weight.

All lead flange work to have standardized threads for nut and spud and uniform length and weight of sleeves.

Convention of South-West Waterworks Association.—The 9th annual convention of the South-West Waterworks Association will be held at New Orleans, La., Sept. 20 to 23rd, inclusive. The St. Charles Hotel will be official headquarters. At the present time the South-West Waterworks Association embraces the following states: Nebraska, Kansas, Texas, Arkansas, Mississippi, Missouri, Oklahoma, New Mexico, Louisiana, Alabama. Other states will probably be taken in at the New Orleans convention. Jos. W. Ivy, 716 Scarritt Blk., Kansas City, Mo., is Chairman Publicity Committee.

Method of Cleaning Filter Sand at Chain of Rocks Filtration Plant

Early in the spring of 1919 the sand in the Chain of Rock filters of St. Louis, Mo., was found to be caking, the grains being held together by a soft coating, which could be removed slowly by washing, but was very hard to dissolve and violent agitation was necessary to remove a small per cent of it. Hard patches appeared on the bed, and the wash water distribution became very unequal. The gravel also was slightly cemented together and it was deemed advisable to clean both the sand and the gravel and repair any broken or loose strainer plates that might be found. The problem of cleaning the sand and gravel economically was carefully studied and a crude experimental apparatus constructed and tried out in the filter house, which led to the construction of the plant now in use. An interesting description of this plant and the method of cleaning the sand is given by Mr. C. M. Daily, engineer in charge supply and purifying section, in the last annual report of Edward E. Wall, water commissioner of St. Louis, from which the notes following are taken:

Sand Cleaning Plant.—The plant consists of four water jets with ¾-in. nozzles and 1½-in. to 2⅜-in. throats, 4-in. discharge pipes, one stationary sloping gravel screen, having four sizes of separation with a hopper underneath each screen, a truck for hauling the gravel from the screen to the place desired and a sand blast machine for cleaning the holes in the strainer plates.

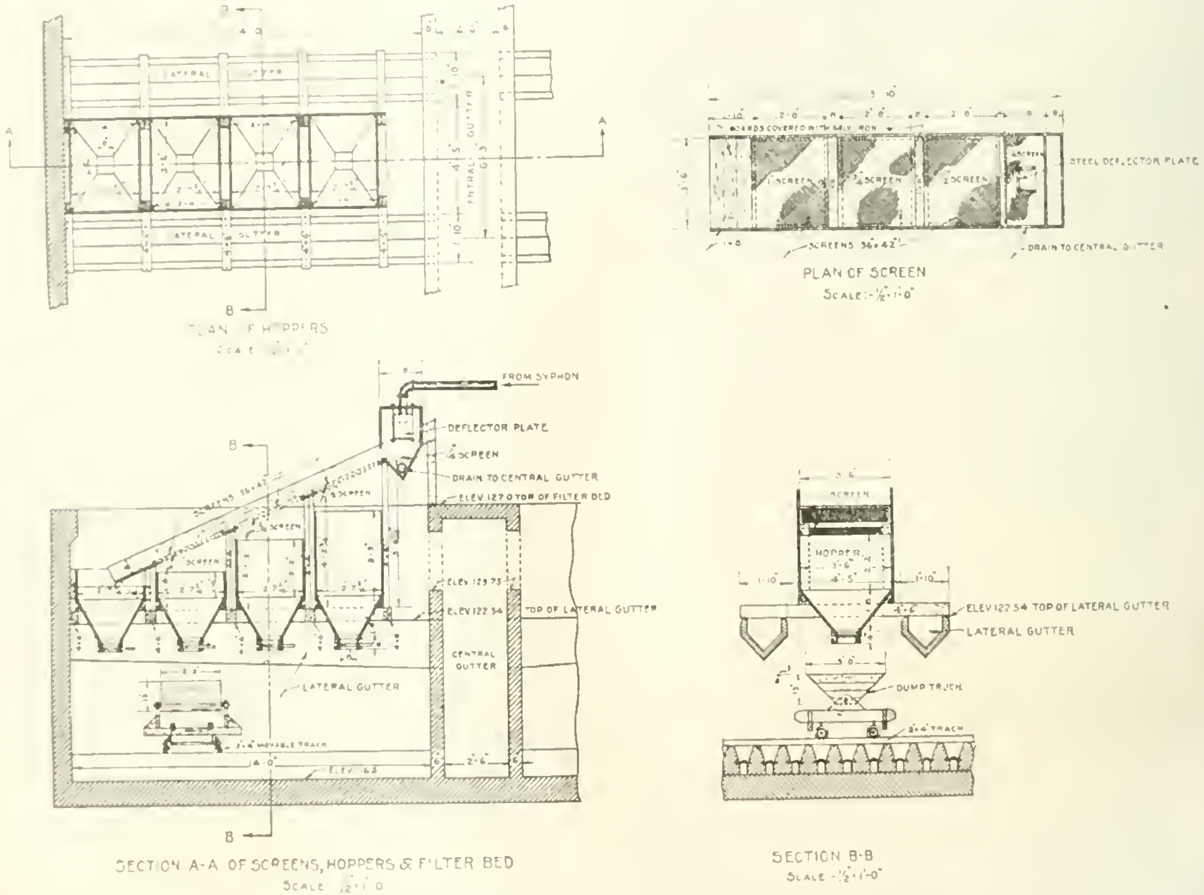
The sand is cleaned by these water jets, one being placed in each half of the filter bed on top of the sand and discharging into the opposite half of the bed or to the opposite end of the same half of the bed, into a wooden box 12 in. square and 4 ft. deep, containing a series of sloping screens. Water at about 100 lb. pressure is used in the jets.

In operating, the wash water is turned on from 1/10 to ¼ the normal rate, which allows the jet to sink through the sand to the gravel and which also furnishes the means of transporting the sand from the discharge of the jet to the suction at the opposite end of the same half of the bed. The wash water flows out through the sewers, carrying away the coating removed by the scouring action of the water passing through the jets and screens.

The sand washing is continued about five hours without the aid of any manual labor, but at the end of that time the discharge from the jets is still turbid, an average of 2.14 per cent coating has been removed, amounting to a weight of 7,000 lb., leaving about 4.87 per cent of coating on the sand, which is further reduced by about ½ per cent by again jetting the sand from one-half of the filter to the other side, which has the gravel already screened and properly placed.

During the experimental work one-half of a bed was jetted into the other half without washing and the coating removed settled in a layer on the sand and could not be removed by the ordinary process of washing the filter. It was only broken up in small pieces or mud balls.

It was found economical to remove all the sand from one bed and the gravel from one-half of the bed at one end of the plant, in order to have room to screen and place the gravel and clean the strainer plates, so that when the gravel and sand had been cleaned in all of the 40 filters, except one, it would be filled out with the gravel and the sand removed and set aside from the first.



PLAN OF HOPPERS
SCALE

PLAN OF SCREEN
SCALE:-½"=1'-0"

SECTION A-A OF SCREENS, HOPPERS & FILTER BED
SCALE ½"=1'-0

SECTION B-B
SCALE -½"=1'-0"

Gravel Screens and Hoppers at Chain of Rocks Filtration Plant.

Method of Cleaning Gravel and Strainer Plates.—The strainer plates in the half bed from which all material has been removed are cleaned with a sand blast. The gravel from the adjoining half bed is shoveled into a jet and discharged into a box which diverts the water which escapes through the screens into the sewer. The gravel rolls over stationary screens, assisted by men with rakes, and drops in four hoppers suspended from the wash water gutters. It is discharged from the hoppers into a small truck, which is wheeled and dumped where desired on the half bed where the strainer plates have been cleaned. Sand from the half filter adjoining the one from which the gravel was removed is now jetted on the cleaned gravel in place. The lower 2 in. of sand is shoveled into the jet, the rest flows to the jet as described before.

The sand blast requires 30 lb. air pressure and supplied with sand passing through 1/20-in. mesh screen. About 1 cu yd. of sand is used per filter bed.

The sand nozzle used is 3/16 in. in diameter and is made of ½-in. pipe by drawing it down and drilling to size.

One man cleans the plates in one-half bed per day. The plates cleaned in this manner have over 97 per cent of the holes perfectly cleaned and the top sides of the plates bright. The under side was found to contain a coating which stil remains The coating on the un[illegible] gave the following analysis.

	[illegible]
(ZnO)	[illegible]
(SiO₂)	[illegible]
(CaO)	[illegible]
(Al₂O₃)	[illegible]
(PbS₄)	[illegible]
Loss on ignition	[illegible]

The gravel from one bed in p[illegible] the jet and over the screens has about 450 lb [illegible]. Whatever coating remains is hard and [illegible] to cement the gravel together.

Up to May 1 last 36 of the 40 [illegible] cleaned in this manner The sand, while [illegible] 4 per cent of coating, has no tendency to cement [illegible] the effective size remains below 4 of a m.m.

The analysis of the coating on the [illegible] gravel is as follows:

	[illegible]	[illegible]
(SiO₂)	[illegible]	[illegible]
(Fe(OH)₃)	[illegible]	[illegible]
(Al(OH)₃)	[illegible]	[illegible]
(CaCO₃)	[illegible]	[illegible]
(CaSO₄)	[illegible]	[illegible]
(Mg (OH)₂)	[illegible]	[illegible]
Clay	[illegible]	[illegible]

The total quantity of coating on the sand averaged 7.01 per cent of its weight, while on the gravel the coating amounted to 1.93 per cent of its weight.

The cost of the work per filter unit was as follows

Labor	[illegible]
Wash water	[illegible]
Tap water	[illegible]
Total	[illegible]

The wash water was estimated at $20.60 per million gallons and the tap water at $19.61 per million gallons.

The plant cost $750 or $18.75 per filtering unit and will be useful for future work.

The cost of jetting the sand for five hours per filter unit was $35.70, divided as follows:

Labor	[illegible]
Wash water	[illegible]
Tap water	[illegible]

It is expected to jet the sand as described above from time to time, should mud balls or cementation of the sand develop.

Jetting the sand from one-half of a filter bed to the other half did not materially change the grading of it, except in only a few filters in which no change in efficiency has been noticed.

Water Supply Telephone Service Carried on Pipe Line.—A 2-wire telephone line about 14 miles long, connecting the [illegible]works of the new Sultan water supply of Everett, Wash., with the city, was built in conjunction with the wood stave pipe line, utilizing steel bands that were rejected as not being suitable for use in the pipe line construction but which were entirely satisfactory for utilization in connection with the telephone line. These bands were attached to the pipe and projected up about 2 ft directly over the center of the pipe, where telephone insulators were fastened and the wires thus strung along the top of the pipe. Aside from making a very economical and satisfactory location for the telephone line, this resulted in protecting the pipe from being used as a pathway for pedestrians. Most of the pedestrians in that country are men going to and from the various timber operations, nearly all of whom wear heavily spiked boots and it is obvious that traffic of this kind on the top of an exposed wood pipe line would be very objectionable. The construction features of the new supply are described by Mr Clinton Burns, the [illegible], in the July Journal of the American Water[illegible] Association, from which the above note is taken.

National Exposition of Chemical Industries.—The Sixth National Exposition of Chemical Industries will be held in Grand Central Palace, New York City, Sept. [illegible] to 2[illegible] inclusive. On the afternoon of Thursday, Sept. [illegible] the Chemical Engineering Symposium will take place. The American Institute of Chemical Engineers will [illegible] in the Palace in the afternoon, and papers of [illegible] will be read. In the evening engineers will [illegible] at the Technology Club. Three other symposiums will be held during the week. One will be on fuel [illegible], [illegible] materials handling, and one on industrial [illegible]

Waterpowers of the Pacific Coast

The American [illegible] to [illegible] that [illegible] are [illegible] have been [illegible] regarded, and that in the not far distant future we shall have to depend [illegible] for much of the power needed in our [illegible] prices and the difficulties of maintaining an adequate fuel reserve have done more in three years to [illegible] awakening than was accomplished by the warnings of experts in the preceding decade. The utilization of our water powers has become one of the most pressing questions of the hour.

The following condensed tabulation from Senate Document 316, compiled on a basis of 70 per cent efficiency, shows the regional distribution of the potential water power resources of this country:

TABLE I—POTENTIAL WATER POWER OF THE UNITED STATES

	—Min[illegible]—		—Maxi[illegible]—	
District	Horsepower	Per cent	Horsepower	Per cent
New England	[illegible]	[illegible]	[illegible]	[illegible]
Middle Atlantic	[illegible]	[illegible]	[illegible]	[illegible]
East North Central	[illegible]	[illegible]	[illegible]	[illegible]
West North Central	[illegible]	[illegible]	[illegible]	[illegible]
South Atlantic	[illegible]	[illegible]	[illegible]	[illegible]
East South Central	[illegible]	[illegible]	[illegible]	[illegible]
West South Central	[illegible]	[illegible]	[illegible]	[illegible]
Mountain	[illegible]	[illegible]	[illegible]	[illegible]
Pacific	[illegible]	[illegible]	[illegible]	42.81
United States	[illegible]	100.00	[illegible]	100.00
Subdivision of Potential Power in Pacific States				
Washington	[illegible]	[illegible]	[illegible]	[illegible]
Oregon	[illegible]	[illegible]	[illegible]	12.27
California	[illegible]	[illegible]	[illegible]	14.50
	[illegible]	[illegible]	[illegible]	42.81

It will be noted from the above table that nearly 43 per cent of the maximum potential water power in the United States is concentrated in the three Pacific states, Washington, Oregon and California. In view of this fact the paper presented April 9 at the 37th annual general meeting of the American Electrochemical Society by Mr. F. F. Fowler, of the U. S. Forestry Service, San Francisco, Calif., is of particular interest. An abstract of his paper follows:

Operating and Market Conditions.—California hydroelectric systems are now operating waterpower plants with a combined capacity of about 54[illegible],000 k.v.a., and steam auxiliaries with an additional capacity of 285,000 k.v.a., a grand total of 828,000 k.v.a., or 1,110,000 h.p. The combined installation in hydro plants of Washington and Oregon is about two-thirds that in California.

Throughout the coast there is a power shortage, due to low water and to the rate of installation not having kept pace with the growth of load. This shortage will be most acute this year in California, which is practically 200,000 k.v.a. behind in hydroelectric installation. Plants under construction aggregate about 165,000 k.v.a., but will not begin operation until the last months of 1920 or the beginning of 1921. In the low water season of the coming fall, every available steam-standby will be in operation, plants which have been on the junk list will be resuscitated, and the consumption of fuel oil, which in 1919 reached 1,895,000 bbl., will be greatly augmented. In June and July, 1919, the months of maximum demand that year, the total load on the California hydroelectric systems averaged 419,000 k.v.a., of which 116,000, or 27.7 per cent, was carried by steam auxiliaries. The mean load on the California systems has increased very steadily at the rate of about 35,000 k.v.a. per year.

The average load carried by most of the hydro plants is under [illegible] per cent of their rated capacity, and an annual increase of 35,000 k.v.a. in mean load would therefore necessitate an annual installation of at least 60,000 k.v.a. in hydroelectric generating machinery, after the present deficiencies are made up. In short, California should have a total installed hydro capacity of 800,000 k.v.a. by 1921, and an annual increase of 60,000 k.v.a. each year thereafter, to adequately handle the normal increase in load.

If large electrochemical, electrometallurgical or railway loads are developed, the rate of increase will be proportionally greater.

Detailed figures for the growth of load in Washington and Oregon are not now available, but are being collected by the National Electric Light Association. Unless new power loads are developed within the two states, the growth in load will hardly be as rapid proportionally as in California.

Feasible Sites and Prospective Developments.—The estimates given in Table I serve merely as a basis for regional comparisons of potential power. Far more detailed studies have been completed on certain drainages by the Federal and State governments, municipalities, and engineering and public utility companies. Most of the Puget Sound streams and those in southern Washington have been studied in detail by the United States Geological Survey in co-operation with the state of Washington. Results already published show a total of 232,000 h.p. without storage and 391,000 with storage for the Cowlitz, Nisqually, Puyallup, White, Green and Cedar Rivers, draining the territory between Portland and Seattle, north of the Columbia and east of Puget Sound. Similar studies show an average minimum of 389,500 (since found to be somewhat higher) h.p. for the Klickitat, White Salmon, Little White Salmon, Lewis and Toutle Rivers, draining into the Columbia from the north, between the mouth of the Cowlitz and The Dalles. The Yakima, which drains the basin east of the Columbia, will produce only 12,000 h.p continuously, but 105,000 h.p. may be developed during the irrigation season. Natches River, principal tributary of the Yakima, will yield 57,530 h.p. continuously without storage, and 97,950 h.p. with storage, while its mean for the irrigation season, with storage, is 160,500 h.p. Clealum River, another tributary of the Yakima, will yield 4,770 h.p. without and 21,560 h p. with storage.

Some of the sites included in these estimates are already in process of utilization, and more complete studies are being made of others. It will, of course, be many years before the streams will be fully developed on the plans outlined.

Among the most important power developments is the proposed municipal system of the city of Seattle on the Skagit River, in the extreme northern Puget Sound drainage. Carried to completion, this system will comprise 200,000 or more horsepower.

Developments located at Priest, Kettle, and Rock Island Rapids and The Dalles on the main Columbia have been proposed from time to time, but investigations of power possibilities at The Dalles appear to have been carried farther than for the other sites.

A detailed report of power available at The Dalles was prepared by co-operation between the State and Federal Governments, in 1913.* The project contemplated the development of power at Five Mile Rapids, near The Dalles, 90 miles east of Portland and 187 miles above the mouth of the river. The minimum recorded flow at this point was 41,900 cu. ft. (1,300 cubic meters) per second, and the maximum 1,170,000 cu. ft. At an average low water discharge of 50,000 second-feet the estimated net head was 105 ft.; and at a high water discharge of 800,000 second-feet, 45 ft. It was estimated that 480,000 h.p. could be developed practically continuously, and that there would be 120,000 more available for eleven months, an additional 100,000 for ten months, and still 100,000 more for eight months, giving a total development of 800,000 h.p that might be considered economically justifiable by stream flow conditions. It was estimated that the cost would be $104 per horsepower for a development of 480,000 h.p., $62.50 per horsepower for 800,000 h.p., or $46.30 per horsepower on the basis of the total rated capacity of generator (1,080,000 h.p.) that would have to be installed in order to secure the continuous output of 800,000. The output would operate at its full capacity during only four months of the average year.

By way of comparison, only 150,000 h.p. is installed at the great Keokuk plant, and 498,000 in all plants on both sides of the river at Niagara Falls. It was estimated that with only 480,000 h.p marketed at The Dalles, and the plant financed by sale of 6 per cent securities at a 10 per cent discount, cost of power would be $15.13 per horsepower year, allowing for a proper depreciation and maintenance fund, but no profits to the company making the development. This price was also based on the assumption of an immediate market for all power. Further estimates show that "if, however, the surplus power of 320,000 h.p. could be sold at rates equivalent to 80 per cent of the price of the continuous primary power for eleven months' service, 60 per cent for ten months' service and 30 per cent for eight months' service, then the selling price of primary power under conditions as above would be reduced to $11.02 for 6 per cent securities sold at 10 per cent discount." The report on the project covered in detail the various possible outlets that could be found for the great amount of energy available, and the result showed that neither existing nor prospective industries would justify construction of the great plant. The most logical power market for a development of this size would be as a supply for a large electrometallurgical or electrochemical industry, and the study disclosed that the site was so handicapped by remoteness from sources of raw material and from market that it would not prove under present conditions a commercial success. The only possible justification for this development from an electrochemical standpoint was found to be for the manufacture of ammonium nitrate.

The state engineer of Oregon has made tentative studies of other large projects on the Columbia, Snake, Deschutes, Rogue and Klamath, capable of continuous output of 2,401,000 electric horsepower.

A tabulation of proposed developments in California prepared by the writer in October, 1919, showed a combined proposed installation of 2,100,000 k.v.a. Many well known possibilities were not included. It appears, therefore, that the state's potential supply is ample for years to come.

The Electrochemical Outlook.—That the very large waterpowers of the Pacific Coast will eventually be utilized as a source of energy for electrochemical and electrometallurgical industries none can doubt, but the date of their utilization is highly uncertain. Were unit cost of construction the only possible deterrent, many large developments would be under way today. Availability of raw materials and the market for the finished products are the most serious handicaps. The results of investigations carried out in connection with the Columbia River project are, unfortunately, general in their application. In connection with that project, industry after industry was investigated as a possible outlet for large blocks of power, and abandoned as probably unprofitable under prospective market conditions. That the site is one of the most wonderful in the country cannot be denied, but its development is for the future, and not the present.

The earliest development of extensive electrochemical and electrometallurgical industries on the Pacific Coast will probably be on Puget Sound, where there is ample waterpower susceptible of development at relatively low unit cost, in moderate-sized units, and in such close proximity to tide water as to minimize transmission costs and losses. The Columbia River and lower Willamette near Portland, offering similar advantages but to a less conspicuous degree, may be expected to follow in turn. The writer does not anticipate that California will ever compete with her northern neighbors on a large scale in electrochemical manufacturing for export (especially in those branches of the industry where power cost is a large percentage of the total cost). Its manufacturing for the local market will probably far exceed that in the other two states. Natural conditions in California lead to high unit costs in hydroelectric installations, especially where long trunk transmission lines are included. In order to get the most favorable power rate, it would therefore be necessary to establish the electrochemical industry near the generating station, which may be from 90 to 175 miles from tide water, with consequent higher freight charges and shipping difficulties. If, on the other hand, these transportation difficulties are avoided by establishing the industry on tidewater, the cost of power will be considerably greater. Market alone will determine whether a given industry can flourish despite these conditions.

Probably the lowest power rate yet quoted in California is $2.50 per kilowatt per month for 24-hour power, based on the maximum average demand for a 15-minute period. This rate was established for the encouragement of electrochemical and electrometallurgical industries other than remelting. It is granted at the option of the power company or upon order of the California Railroad Commission. The base rate is subject to an additional charge of 6 ct. per kilowatt maximum demand for each 1 per cent that the average power factor falls below 90 per cent. A general surcharge since allowed by the Railroad Commission to take care of increase in all generating costs, permits an additional charge of 0.2 per cent per kilowatt hour. The net cost per horsepower year therefore ranges from $35.45 for 90 + per cent power factor and 100 per cent load factor, down to $32.84 with 90 + per cent power factor but only 80 per cent load factor.

---

*"The Columbia Power Project," Bulletin No. 3, accompanying Fourth Biennial Report State Engineer John H. Lewis, Jan. 11, [illegible] by L. F. Harza, Project Engineer.

Operation and Maintenance of the Gunnison Irrigation Tunnel

The Gunnison Tunnel of the Uncompahgre Project of the U. S. Reclamation Service was officially opened in September, 1909, and delivered the first irrigation water in the season of 1910. The tunnel is 30,582 ft. in length and on one tangent except 210 ft. of reverse curve near [illegible].

The first plans contemplated lining the tunnel throughout with concrete, using four classes of section depending upon the material encountered. These sections were later slightly modified and many sections in solid rock were left unlined.

The sections of concrete lining placed were as follows: (1) Hard material, floor flat 11 ft. wide, sides vertical 8 ft. 9 in. high to spring line, rise in circular arch 2 ft. 3½ in.; (2) soft material, floor flat 10 ft. wide, sides flaring so that width at spring line was 11 ft., spring line 9 ft. 2 in. above floor, rise in circular arch 2 ft. 3 in. The grade throughout was uniform—2.02 ft. per 1,000 ft. The unlined rock section was made with a minimum width of 12.5 ft. and minimum height of 13. ft. The floor was concreted throughout.

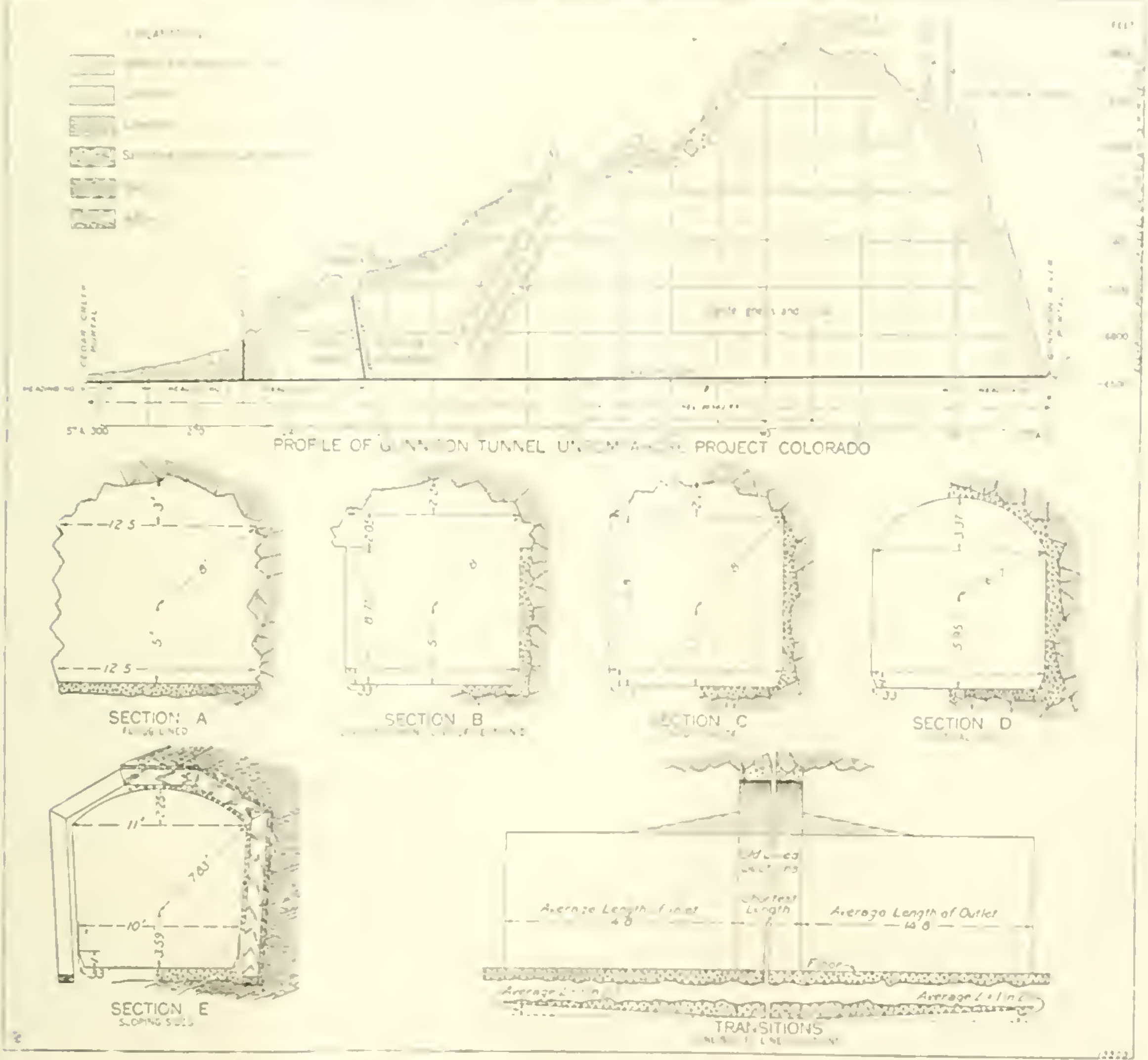
The later condition of the canal, its operation and other interesting results are described by Mr. Fred D. Pyle, former project manager, U. S. R. S., in the July Reclamation Record from which the notes following are taken.

Where the greatest difficulties in construction were encountered the concrete was made heavier than originally planned and those places remain in excellent condition. Between stations 170 and 220 where no exceptional difficulties were encountered during the orginal construction the shale has since swelled and caused cracking and bulging of side walls, and bulging of the floor.

Condition Oct. 1, 1913.—The floor was lined throughout in the original construction. The side walls and arch were lined only where the material was soft. There were no transitions between the unlined and the lined sections. The track and trolley had been left in place. There was considerable débris and concrete that had dropped from the arch lying in the tunnel. In numerous places the floor had bulged upward, and the side walls bulged inward. Inspection also showed that in many places the concrete arch had not been filled in on account of difficulties encountered during construction.

Sixty-five concrete bays had been placed in the side walls between stations 185 + 10 and 190 + 74 and 21 bays between stations 204 + 01 and 205 + 48 to strengthen the side walls during 1912. The floor between stations 190 + 88 and 192 + 3 had been reinforced with concrete bays in the spring of 1911 and the floor replaced between stations 192 + 10 and 1[illegible] + 70 in the spring of 1912, and between stations 21[illegible] + 20 and 220 + 05 in February, 1913.

Work, Winter of 1913-14.—During December, 1913, and January, 1914, 11 concrete bays were constructed in the walls between stations 193 + 68 and 194 + 24; the loose débris was cleared from the tunnel, the ties were removed, and the rails laid against the walls between stations 40 and 85, which was typical of the unlined sections, and between stations 200 and 210 in the lined sections. Gages, consisting of closed wooden boxes in which a strip of blue-print paper was fastened on which the maximum water level was indicated by a change in color, were installed every thousand feet through the tunnel, and the following readings obtained: July 2, 1914, 152 second-feet; July 15, 1914, 282 second-feet; July 2, 1914, 152 sec-592 second-feet; October 15, 1914, 270 second-feet.



Profile, Sections and Transitions of the Gunnison Tunnel of the Uncompahgre Project.

The following average values for the coefficient n in Kutter's formula were obtained:

Station	Flow in second-feet 152	270	282	584	592
10 to 170*	0.0229	0.0262	0.0240	0.0305	0.0319
170 to 306 line	.0173	.0185	.0223	.0187	.0197

*Unlined except floor, 24 short lined sections totaling 3,082 linear feet.

In the above and in succeeding determinations of values of n it was impracticable to segregate the losses due to changes in size and other irregularities in the tunnel section. The values of n computed are therefore higher for both lined and unlined sections than would be the case had a rigid determination of these conversion losses been feasible.

Very little difference was noted in coefficients between sections where the ties were removed and sections where the ties were in place. The coefficients varied greatly for individual sections but were reasonably uniform for the various discharges, increasing with the discharge in the first portion of the tunnel and being erratic in the lower portions of the tunnel.

No work was done during the winters of 1914-15 and 1915-16.

Work, Winter of 1916-17.—During the winter of 1916-17 extensive repair and construction work was undertaken: 203 ft. of bulging sidewalls were replaced, 98 ft. of tunnel lined, 102 ft. of tunnel lined to spring line, and 8 transitions constructed. The floor of the tunnel from station 200 to the end was carefully cleaned and from station 200 + 10 to 266 + 25 was plastered with ½ to 1 inch of mortar. The ties and all loose débris were removed from the tunnel and the rails laid against the sides.

An electrical system for determining the elevation of the water in the gage boxes while water was running was installed, but owing to excessive moisture conditions did not prove a success.

Effects of Square Shoulders and Transitions.—On April 18, 1917, the first trip was made through the tunnel with a Ford car, which demonstrated the practicability of using an automobile for inspection purposes. Before this time it had been necessary to walk, carrying ladders for inspecting the gages and supplies for making repairs to the gages when necessary. The first trip with an auto was made just after a head of 510 second-feet had been carried, and the watermarks were very distinct on the walls. These watermarks showed the contrasting effects of the square shoulders and of the transitions on the flow. At many of the square shoulders the water line was about a foot higher than it was 20 ft. downstream, while at the transitions there was a difference of only about 0.2 feet. The water line also indicated considerable wave action at the gages in the concrete lined section which carried across the tunnel and could be noticed on the opposite wall 16 to 20 ft. below the gages. Standing waves were in evidence in a number of places, especially in the narrow uneven sections between stations 185 and 200.

On July 18, 1917, a set of readings of the watermarks was made after a discharge of 650 second-feet.

On August 16 and 17 the discharge of the tunnel was tried out to determine the maximum capacity. With a reading of 13.1 feet on the east portal gate, the maximum water depth obtainable at that time and stage of the river, the discharge was 900 second-feet. An inspection of the watermarks was made on the 17th. Fairly definite marks were found in the lined sections, but more or less indefinite in the unlined sections.

The following is a comparison of the value of n as determined from these measurements.

Station.	Flow in second-feet. 650	900
10 to 170. Unlined (except floor and 22 short lined sections, totaling 3,292 linear feet), 8 transitions in place	0.0295	0.0235
170 to 300. Lined, floor partly smoothed	.0160	.0140

Although the methods used to determine the water level were crude, and the number of readings small, the results indicated improvement in flow conditions, due to removal of ties, the construction of short concrete sections and transitions, and the smoothing of concrete floor.

Work, Winter of 1917-18.—During the winter of 1917-18, 137 ft. of tunnel were lined complete, 420 ft. to spring line, 573 ft. to roof, and 22 transitions were placed. This work completed the transitions and the lining of all the short unlined sections, so that there were no unlined sections less than 207 ft. long. The above also included lining at the upper end to station 7 + 09, the last 500 ft. being the roof. All rocks projecting into a section 12.5 ft. wide and 12.5 ft. high were removed; 531 ft. of bulging floor were replaced 6 in. below grade in order to increase the cross section of the tunnel; 847 ft. of bulging wall were replaced and 101 concrete-lined bays were constructed in the side walls.

The rock section was found to be small in many places, especially in the first 4,000 ft., and it was enlarged to a minimum width of 12.5 ft., and minimum height of 13 ft.

During the spring of 1918 a set of metal cup gages was established in the tunnel. The cups were arranged 10 to the foot in the inside of a galvanized metal trough which was fastened to the gage boards by means of staples and nails.

On account of the heavy demand for water, readings were not secured during the irrigation season. Four readings were secured in October as follows: Oct. 24, 500 second-feet; Oct. 25, 390 second-feet; Oct. 26, 325 second-feet; and Oct. 27, 565 second-feet.

The following average values for the coefficient n were obtained:

Station.	Flow in second-feet 325	390	500	565
10 to 170[1]	0.0224	0.0236	0.0258	0.0255
170 to 300. Lined	.0163	.0163	.0169	.0161

[1] Unlined, except floor and 14 short lined sections totaling 3,820 linear feet

These results were more uniform and encouraging than any previously obtained; 905 second-feet of water was the maximum carried in the tunnel in 1919, when the gages read 12.8 feet at East Portal and 6.65 feet at West Portal, as compared with 13.1 feet and 6.33 feet in 1917 for 900 second-feet.

Work, Winter of 1918-19.—No work was done in the tunnel except for a thorough cleaning of the floor, removal of trolley wire and hangers, and the smoothing of a few spots of rough floor.

Eight sets of readings were secured as follows: 108 second-feet, Oct. 31; 149 second-feet, Nov. 3; 196 second-feet, Oct. 27; 206 second-feet, Nov. 4; 270 second-feet, Oct. 28; 330 second-feet, Oct. 28; 484 second-feet, Oct. 29; 532 second-feet, Oct. 30, 1919.

The following average values for Kutter's n were obtained:

Station.	Flow in second-feet 108	149	196	206	270	330	484	532
10 to 170[1]	0.021	0.023	0.021	0.021	0.022	0.025	0.022	0.024
170 to 300	.020	.019	.017	.017	.016	.016	.016	.016

[1] Unlined except floor and 14 short lined sections, totaling 3,820 linear feet.

During January, 1920, a heavy wooden bulkhead was constructed to prevent the flow in the tunnel striking the side wall at the foot of the incline between station 2 + 09 and 2 + 39, causing swirls and back currents.

Conclusions.—The results of past investigations indicate that the coefficient n in Kutter's formula for the first 17,000 ft. of the tunnel is 0.023 to 0.024, and for the remaining 13,000 ft., 0.016, which indicates that sections unlined, except for floor, may have a coefficient of 0.024 to 0.026.

An examination of the detailed data shows that in the section unlined except for floor, the value of n increases with the discharge which is to be expected as the percentage of rough perimeter increases with the depth, and that the value of n decreases in the lined section as the discharge increases.

On account of inabilty to eliminate standing waves, water splash, etc., all methods tried in determining the gage heights have left much to be desired.

It appears, both from observation and calculation, that the unlined sections are the deciding factors affecting the maximum discharge. With value of n = 0.016 the lined sections will carry 1,000 second-feet, and with values of n = 0.024 and .026 the unlined sections, with a width of 12.5 ft and depth of 12 ft., will carry 986 and 912 second-feet, respectively, with a possibility of reduced discharge if sealing takes place.

Frequency of Different Classes of Leaks in New York City Mains.—Some interesting information on this subject was given by Mr. Fred B. Nelson, engineer in charge water measurement and water waste of the New York City Department of Water Supply, in an informal discussion last February before the New York Section of the American Waterworks Association. He stated that the leaks stopped during 1919 totaled 9,348,000 gal. per day. The average size of the leaks located was 54,000 gal. per day. The different classes were as follows:

	Number.	Per cent.
Live service	87	50
Abandoned service	17	10
Blown joints	63	36
Leaking valves	5	3
Cracked pipe	1	1
Total number of leaks	173	100
Openings per leak (excluding the above mentioned one requiring 25 openings)		1.2
(Including the one with 25 openings)		1.32

Application of Unit Basis for Determining Land Values for Assessments

The city of Bethlehem, Pa., ha[illegible] in operation a new system of real esta[illegible], as the result of which assessments are now ma[illegible] bureau of assessments, in place of 13 w[illegible], each working independently of the others; [illegible] are now assessed separately with 100 per [illegible] for land and 50 per cent for improvements. [illegible] are now fixed by using a scientific appraisal sy[illegible] block values per foot front, the tax d[illegible] tax roll has been increased from $22,000,000 to m[illegible]. An interesting review of the method [illegible] assessments followed in Bethlehem is given by Mr. [illegible], City Manager, in a recent issue of [illegible], from which the matter following is abstracted.

The Bethlehem System.—As in all cases of proper assessments the aim in Bethlehem has been to provide a real estate assessment which will secure such a valuation of every parcel as to assure its bearing a proper relation to all other parcels in the city.

After considering various known systems, including the Somers, Pleydell Hoffman-Neill, and others, the tax authorities in Bethlehem decided upon a system very similar to several of these forms in various respects, but identical to no one, particularly as regards the adoption of a curve to control percentages of value for lots of varying depths.

At the outset a lot having a frontage of 25 ft. and a depth of 140 ft. was adopted as standard. A table of percentages of value for each foot in depth was adopted. In cases of corner lots 20 per cent was added to the value of the first 25 ft. of frontage, for those parcels on the corners of main intersecting streets, and 10 per cent was added for those parcels on corners of alleys and secondary streets.

Each block throughout the city was given a distinct unit value per foot front. The principal factor was to determine its value through average recent sales. Rentals of property in the block were also used as a checking, and in some cases a determining factor, particularly where no recent sales were made to afford the City Assessor a basis of valuation.

Determining Land Values.—In arriving at the land value of an improved property which had been sold comparatively recently the assessor has estimated the value of the building or improvement, this estimate being based upon tables of standard values for various types of structures, and on his general knowledge of building values, and construction costs, in which phase of the problem he was materially aided by contractors and builders. Replacement values as of the date of the making of the assessment were not used because of the very unusual conditions in the building trades and the exceptional high costs of construction at the time of making assessments.

After fixing the building value for assessment purposes this valuation was deducted from the sales consideration, the result giving tentative value of land, with several sales in a block to guide, and using neither the highest nor the lowest, nor even an absolute average, and by reducing the land value thus far secured to a value of the same parcel to a standard size lot, 25 ft. x 140 ft., the assessor was able to determine the unit value per foot front for the standard sized lot in that block.

This procedure was followed in every block in the city. It was necessary, of course, with the adoption of this system of unit values, to have available data showing dimensions of every parcel of real estate in the city, there being more than 8,000 such parcels.

Preparation of Property Maps by Engineering Department.—At the start of the work, early in 1918, Council by ordinance provided that all property owners should file their deeds in the office of the City Engineer for recording.

From the deeds the Bureau of Deed Registry made copies covering the date of the document, the description of the parcel, from whom and by whom purchased, and the consideration of sale, and such other information from the respective deeds which would prove of value to the assessors.

Using this as a basis, and supplementing this information by field surveys, the Engineering Department property maps for every section of the city, ex[illegible] three of the annexed territories, which are not [illegible] the compilation up to the beginning of the present year, the city was divided into 13 districts, the districts followed by the wards as previously established. The property maps were divided into district or ward books, and sub-divided into blocks sections with each block numbered, beginning with one in each ward.

These property maps are on a scale of 50 ft. to the inch, the maps showing the dimensions, frontage and depth of each parcel of real estate, the ward, block and lot number, beginning with one in every block, name of the owner and the street number of the parcel.

In addition there was prepared a key map on a scale of 200 ft. to the inch covering all the property on the north side of the river and a similar map on a like scale covering all the property on the south side of the river.

Immediately upon the adoption by the assessor of the unit value per foot front of land for each block in the city these values were placed upon the key maps so as to afford a ready reference for the assessor, Board of Revision of Taxes and Appeals, and for the citizens. This is particularly advantageous in comparing values of adjacent blocks or sections of similar character or commonly considered equally attractive and valuable land.

Land Values and Sales Prices.—In the consideration of land values, particularly as pertaining to sale prices, cognizance was taken of various influencing factors; as an example: due to war conditions and the very great demand for properties in all sections of the city, but particularly on the South Side, formerly the borough of South Bethlehem, where large numbers of war workers in steel and munition plants had come to the city, prices for real estate had jumped far beyond any price heretofore known; likewise rents were very much higher than ever before. In the foreign sections, due partly to the tendency of foreigners to greatly overcrowd in boarding and rooming houses, and partly to the necessity of such overcrowding from inadequate housing facilities, landlords were in many instances reaping an undreamed-of harvest. While the assessor must and did take into consideration sales prices and real estate values on a basis of rental income capitalized at the prevailing local rate, he should and did discount materially these war prices from sales and of rentals.

The community had been assessed heretofore by ward assessors, each working independently of the others, and in most instances, as well as in most years, without any knowledge or consideration of the factors or percentages of actual values used as a basis of these separate assessments.

With the adoption of a unit system of land assessments based upon actual cash or 100 per cent valuations for land and 50 per cent for improvements and the same applied uniformly throughout the entire city, it was but natural that the percentages of increase of value in the different sections or wards were at great variance.

Taking the city as it existed January, 1918, and without consideration to the three most recently annexed portions of adjacent townships, there was a total of 8,410 parcels of real estate in 13 sections or wards. The smallest section contained 361 parcels, the largest 1,183. The aggregate duplicate was increased from $22,286,748 to $50,789,304, or an aggregate increase of 127.89 per cent. Considering the increase in the various districts it was found they varied from 63.19 per cent to 214.53 per cent.

The properties of the steel industry are in the third, fourth and fifth wards, accounting for the very heavy increase in these three districts.

This naturally would seem out of all reason, to any person not familiar with the local situation, but a careful study shows that it is due entirely to the great variance of assessment ideas imposed upon the community by the district system heretofore in effect.

Effect of System on Large Industries.—Bethlehem is regarded to a certain extent as a one industry community, due to the fact that the steel mills employ many times the number of people at work in any other plant. Partly because of this and partly as a result of two of the five City Commissioners being officers of this large industry, it was felt that with the revision of assessments under a uniform city-wide policy based on unit values for land this industry would be favored very materially.

Just the opposite has occurred. While the aggregate increase represents 1,789 per cent. the assessment of this industry was increased 323 per cent.

Results. Court Actions on the New Assessments.—As a result of these changes, and particularly due to the varying degree of increase in the various districts, it follows naturally that considerable agitation should result. Those property owners who had escaped bearing their proportion of the tax burden under the former system, and were to be required to meet their fair share of taxation under the new system, of course, were loud in their condemnation in the new assessment. With a great many feeling sincerely hurt and with a few who saw the opportunity to make political capital of the situation, a Tax Payers' League was formed to avoid the new assessments.

Maintaining that the adoption of a system of unit land values mean the application of a "mechanical" means of arriving at land values, and that by such a mechanical method, so-called, it was impossible to arrive accurately at actual values; the entire assessments were attacked in the court by the filing of a bill in equity to restrain the Commissioners from placing the assessments into effect, and from collecting taxes on such assessments. This application to the court, of course, came after the preliminary consideration of the appeals by the Board of Revision of Taxes and Appeals (composed of the Mayor and members of the Council) in which consideration the Board visited every parcel of land in the city. While the attorneys for the League sought to throw out the new assessment roll by involving legal technicalities based on required dates for completion of assessment roll by the assessor, and dates of hearing of appeals by the Board of Appeals, the principal attack was based upon the mechanical system, so-called, averring that the Constitution and statutes and the decisions of the courts of Pennsylvania expressly prohibited the adoption of any such mechanical system. Briefly, this case was decided in favor of the city and of the assessment roll by the court refusing to grant the restraining order for which the plaintiffs petitioned.

As to the adoption of the unit system for land values (the so-called mechanical system) the court held that a municipality could properly adopt and apply such a system for arriving at real estate values, and in so doing establish equalization of values throughout the entire city. In addition, of course, to holding that the adoption of the so-called mechanical system was a proper course to pursue, the court held that there was no evidence of inequalization such as would warrant the granting of a restraining order. Dealing with these phases of the question the court found in dismissing the bill in equity brought by the taxpayers against the city of Bethlehem to set aside the assessment and enjoin the city authorities from collecting any taxes for 1919, that the provision of the Clark Act regulating the time for the completion of the assessment by the assessor and completion of the labors of the Board of Revision of Taxes and Appeals were directory. A formula was used by the assessor in arriving at the public sale value of property; the court held the ascertainment of the fair public sale value of property for taxation purposes is not a matter of formulas but calls for the exercise of the judgment of the assessor upon a proper consideration of all the relevant facts; the assessor may take into consideration a formula based upon mathematical calculation and use his judgment as to the extent of which it shall be employed.

In addition to the Bill in Equity the owners of something less than 700 parcels of land filed appeals with the court. A great many of these were filed before a review of the situation by the Board of Appeals, since which time corrections and alterations have been made. While the court has heard none of these appeals as yet, it is most probable that with the final revision by the Board of Appeals most of the court appellants will drop out of court and out of the comparatively few remaining it is problematical what the court may do in individual cases.

Forms Used by Bureau of Assessments. Regarding the forms used in the Bureau of Assessments there are, aside from the property maps and cards used for indexing properties and owners, but three forms; of these two are field sheets, the first 4½x7 in., used exclusively for listing names and addresses of non real estate owners, for the purposes of occupation tax, and for listing horses and cattle, which are assessed in Pennsylvania. The other field sheet, 8½x11 in., is used for property assessments. This sheet provides spaces for listing: Ward number, location by street and number, owner's name, and address of owner, date of purchase, price paid, live stock assessable; tenant's (male, over 21 years of age), occupation; street improvements, condition of roadway, sewer, gas and water service; lot improvements (sidewalk, curb and gutter); lot dimensions, unit value, assessed value of land, assessed value of improvements, total assessed value; and in detail provisions for checking; dwellings, size and type, other buildings, size and type, structural conditions and material, number of floors and rooms to each floor; heating, lighting, condition of repair; rentals, date of construction, schedule and class number; depreciation allowances and miscellaneous data or remarks.

The permanent office record consists of one form, 9¼x14 in., for listing non-owners of property for purposes of occupation taxes, and the permanent office record of real estate assessments, also 9½x14 in., one sheet being used for each parcel of property, and each sheet being good for three years, the tri-ennial tax assessment period. This record shows location, names and address of owner, date of building erection and remodeling, building factor applied; name of former owner, street improvement, lot improvements, building improvements, occupation of owner, frontage of lot, depth of lot, unit foot value, lineal foot value, land assessment, brief description of building, building assessment, personal property, value of personal property (live stock), value of occupation, total amount for taxation; and, of course, for indexing and filing purposes, ward, folios, block, lot and information, street numbers.

In the opinion of the writer the only criticism of value which can be directed against the Bethlehem assessment program, as outlined above, is that too much was attempted in too short a period; that more time could have been taken to complete deed records and property maps before applying the unit value for lots, figured on the basis of the foot of frontage and depth of each parcel of real estate. Certain it is that with more time in which to complete the property maps and work up the Assessor's records a majority of the many errors in dimensions would have been eliminated in the Assessor's original tentative assessment. And the elimination of these errors not only would have saved a great amount of detail work in corrections of the assessment roll and the tax duplicate of the Treasurer's office, but, in my opinion, would have diminished the objections to such an extent, most probably, as to have prevented the litigation.

Concrete Sided Ash Cart at Chain of Rocks Filters.—One of the steel frame and bottom wooden sided cars used at the Chain of Rocks filtration plant of St. Louis, for hauling ashes, damaged by hot cinders charring the wood, was repaired by substituting reinforced concrete slabs 2 in. thick cast in blocks 2 ft. 1 in. wide and 10 ft. 6 in. long. The concrete slabs were heavily reinforced by ¼-in. bars running longitudinally 2½ in. c. to c. in addition to a sheet of triangular mesh reinforcing, having an area of 0.05 sq. in. per running foot placed in the center of the slab. The slabs were bolted to vertical steel ribs spaced 5 ft. 3 in. c. to c. and supported by steel brackets which formerly served as supports for the wooden sides.

The concrete was made of 1 part of Portland cement, 1 part of sand and 1½ parts of fine gravel. At the time annual report of the Water Commissioner of St. Louis, Mo., for the fiscal year ending April, 1920, was prepared the car had been in service two months, and the concrete slabs had stood the service satisfactorily. The cost of repairing the steel frame, making and placing the concrete sides and painting the car was $1,085. Only a small per cent of this amount is chargeable against the concrete sides.

Results of Cleaning Water Mains at Charleston, S. C.—The distribution mains in the southern section of Charleston were laid during the eighties, and after 35 years of service their carrying capacity, due to tubercles, had been reduced to less than 40 per cent of that of new pipe. In 1919, the Water Department cleaned six miles of 6-in. mains throughout the older portions of the city. A test to determine the loss of head or friction before and after cleaning showed that on an average the carrying capacity of the mains for the same loss of head had been increased to 2.6 times the capacity before cleaning. The total cost of this work, according to the last annual report of the department, including labor, materials and royalties was $3,267.84 or 10.32 ct. per foot.

Stopping Sink Holes in Irrigation Canals and Construction of Drops in Very Light Soils

The Flathead irrigation project [illegible] of the U. S. Reclamation Service, has a varie[illegible] from coarse gravel near the Mission [illegible] all on divisions lying farther out in t[illegible] as white, with little cover of [illegible] of vegetation under natural con[illegible] classified as "rock meal" by the [illegible] Survey and is the result of the [illegible] period when the valleys were [illegible] part of the prehistoric Lake Missoula.

With the first operation of laterals [illegible], troubles began from sink holes [illegible] bottom of the ditches. Some of [illegible] into the ground and app[illegible] others dropped for a few feet and t[illegible] underground across adjacent fields, [illegible] ditch banks and the topsoil of the [illegible] tances up to several hundred feet. [illegible] of these cavings varied from 2 to [illegible] 15 ft. deep and 30 ft. wide. The [illegible] stopping these sink holes and in the construction [illegible] in the light soils, were described by Mr. C. J. M[illegible], Engineer on the Flathead Project, in the August Reclamation Record, from which the matter following is taken.

Repair of Breaks in Level Country.—Where holes dropped vertically without breaking out in the fields it was found best to allow water to run into the hole for a considerable period as it would generally plug itself and fill up with water, after which necessary repair work consisted in bringing the banks and bottom up to grade with team [illegible]. When the breaks started out across the fields it was necessary to shut out the water from the break to prevent damage to the lands. In some cases the relocation of the lateral was the most economical solution of the repair work, but generally the break in the bank was trimmed down so that the new dirt was placed against sloping sides and [illegible] used as much as possible in the new bank. Water was kept in the ditch as much as possible during the time of repairing in order that the new material might be w[illegible] p[illegible]ed in.

The largest number of sink holes appeared during the first and second year of operation but are still [illegible] with less frequency after four years of operation. They also occur in fields where irrigation water is applied. An explanation for the cause of these holes is that the subsoil which lies in horizontal strata has contracted during the drying-out process following the time when the [illegible] was a lake bed, and vertical cracks have been formed. When the light soil covering the stratified material becomes saturated sufficiently, water breaks through into the cracks and carries considerable quantities of the soil [illegible] into the crevises. Some of these [illegible] go to a great depth vertically and others are cut off by a horizontal stratum and are open for a considerable distance parallel to the surface of the ground.

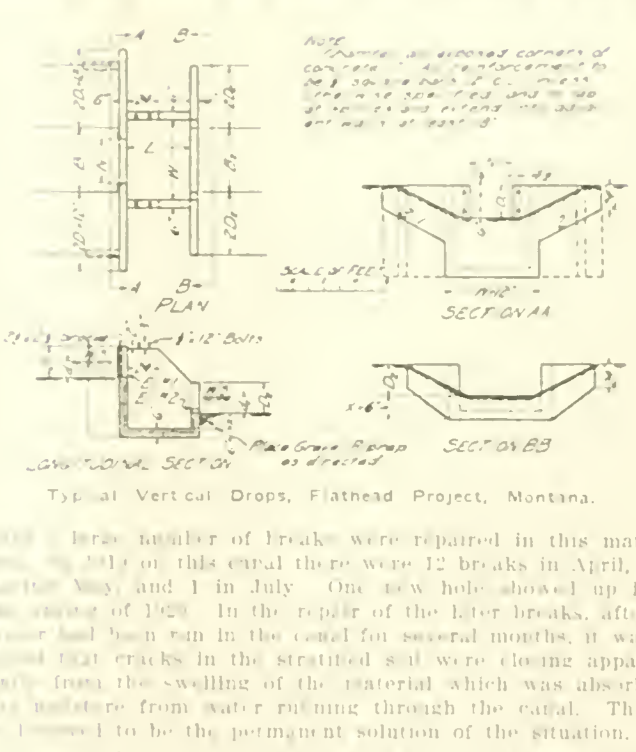
The repair of these breaks in level country is not a serious matter but for the fact that they are very [illegible]. It has not been uncommon to have [illegible] each, breaking in succession as soon as [illegible] are repaired and water again turned in.

Repairing Break on Steep Sidehill Location.—A more serious type of break appeared in the Camas A Canal between miles 8 and 10 where the location is on steep sidehill with light top-soil with the excavation [illegible] into the stratified subsoil. The first water [illegible] canal dropped into cracks in the bottom in [illegible] of places, went down vertically from 5 to 15 ft. [illegible] the hill below the bank sometimes [illegible] than the canal grade. As the stratified material [illegible] it was possible to turn out the water [illegible] before these holes had assumed much area.

A part of the season of 1918 was sp[illegible] these holes by puddling with [illegible] after the break occurred. [illegible] proved capable of [illegible] of water. It was found [illegible] head of water [illegible] ft. in diameter had been [illegible] the cuttings leading into the [illegible] were cut out. These holes [illegible] under the canal bank than the [illegible].

The first step in the repair [illegible] material. [illegible] The canal bank which [illegible] was caved down into the [illegible] fortunately on the lower side of the canal and [illegible] in filling the break. Water [illegible] during the process of filling [illegible] through the canal as soon as the repair work was completed.

[illegible] of the [illegible] broken the second time. During the fall of [illegible] large number of breaks were repaired in this manner. [illegible] on this canal there were 12 breaks in April, 6 during May, and 1 in July. One new hole showed up in the spring of 1920. In the repair of the later breaks, after water had been run in the canal for several months, it was found that cracks in the stratified soil were closing apparently from the swelling of the material which was absorbing moisture from water running through the canal. This [illegible] to be the permanent solution of the situation.



Typical Vertical Drops, Flathead Project, Montana.

Concrete Drops for Light Soil.—In addition to the troubles on account of sink holes there has been great difficulty holding structures in the light soils, especially on the Camas division. This has been most marked with vertical drops on account of the greater difference in head above and below the structure in a short distance. Concrete structures appear to give more trouble than wooden ones of the same type, are more difficult to repair, and are liable to more injury from failure. From experience in the light soil of the Camas division it is advisable to make the first installation of structures in this kind of soil of wood. If desired to have concrete structures they can be placed when the wooden ones have rotted out and probably would prove satisfactory as there is a great change in the soil and its resistance to erosion by water after it has been wet and settled by seepage from water in the ditch.

The type of concrete vertical drop which was built was designed to use as little concrete as possible on account of the long haul for all of the material used. The upper wing walls and cut-off walls extended straight into the banks of the ditch at the head of the drop and were beveled off at the lower outside corners corresponding to the side slopes of the ditch. These structures failed repeatedly, the break occurring under the cut-off walls at the beveled corners. They have finally been made secure by adding sandy gravel to the clay in puddling, and by placing a large percentage of sand and gravel next to the concrete wall, above the structure in the sides and bottom of the ditch. This material prevents shrinkage cracks from forming next to the concrete. It is advisable, as shown by dotted lines in Fig. 1, to change the design of this structure so that the cut-off walls run down to the bottom of the pool the full length of the wing walls, with additional cut-off walls at right angles extending upstream near the ends of the wing walls.

The common type of chute is more secure if built with an approach and double set of cut-off walls. The use of concrete slabs in these structures, with longitudinal reinforcing of steel bars, is much more reliable than grouted paving. The grouted paving drops often fail from washing out of the foundation which occurs if there is even a very small leak through the structure. The concrete slabs will hold up under such conditions unless badly undermined and are easier to keep free from leaks. The use of elastic cement on cracks in concrete in flumes, lined sections, and chute drops has been very effective in preventing the small leakage which often is the cause of settlement of the foundation or sliding of steep slopes. One good application will last several seasons.

Cut-off walls placed in trenches have proved more reliable than when formed to the bottom and puddled in. The latter method has been common practice when standard forms are used in construction of many structures to the same design.

Experiences with Turnouts, Checks and Weirs.—The standard type of concrete pipe turnout for laterals and farm deliveries was installed on the Camas division and proved unsatisfactory on account of the unequal settlement of the concrete end walls and the concrete pipe in the barrel. This caused the breaking of the pipe which entered the end walls in a large majority of the turnouts. Later construction had wooden end walls and concrete pipe barrels and has been more satisfactory on account of the flexible joint between the pipe and the end walls. Well made concrete pipe will go through a failure of the structure without breaking and be in condition for replacement. Leakage in the joints of the pipe has given trouble in new banks. This is due to settlement or lack of sufficient concrete in the collars placed over the joints. Better results would be obtained by using a straight wooden turnout with future replacement with the concrete type, if desired, after the banks are well settled as would be the case by the time the wooden structure had become rotted out. Straight wall checks and weirs, without support on either side except from paving or riprap, have been hard to maintain. These wash out under the cut-off walls and around the ends and have a tendency to tip over. Paving or riprap below the structure is not a substantial support, especially if the bottom of the ditch below cuts out on account of too steep grade. Brackets placed on the down-stream side about half way between the opening and the end of the wall give support and prevent washing out around the ends. Oversize gravel placed between the brackets and on the sides and bottom of the ditch below make better riprap than large square or angular stone and are often more economical to place. If the cut-off walls extend 2 ft. or more below the grade of the ditch, cutting under can be remedied by using sand and gravel with the clay in puddling, with a liberal amount of the sand and gravel on the surface of the ditch. The brackets mentioned should extend down to the bottom of the cut-off walls. The amount of gravel riprap needed will depend on the capacity of the ditch and can be added to during operation if not sufficiently supplied at first.

Puddling in Light Soils.—The process of puddling in light soils differs from that in heavier clay or gravelly soils. It is not sufficient to throw the material into water or simply to throw water on layers of the material. The puddle must be worked somewhat after the manner of placing wet concrete in order to get it well wet, the air removed, and the material compacted.

Dry tamping is not successful. The best of puddling will shrink and crack if allowed to dry out and for that reason the puddling of new structures ahead of the time when water is run in the laterals is of no value. If it were possible to place all lateral structures after water can be run in the laterals the work would be more economical and satisfactory from the standpoint of operation and maintenance. At least the puddling should be postponed until water is running in the ditches so that it may be held against the puddled material until settled.

Some Aspects of Electrolysis of Pipes

Before the advent of the electric street railway, the life of iron pipes, especially those made of cast iron, seemed to be almost indeterminate. After the installation of the electric street railway, frequent breaks in pipes were experienced and the cause for these failures seemed to be shrouded in mystery. Some interesting aspects of this subject have been taken up and discussed by Gellert Alleman, Professor of Chemistry, Swarthmore College, in a paper by him read before the recent Montreal Convention of the American Water Works Association. The following notes are taken from his paper:

An examination of installed pipe sometimes revealed the fact that after the pipe had remained in the earth for a time, in apparent good condition, it suddenly began to deteriorate. Small or huge warts or concretionary deposits began to appear in spots on the outer surface. Frequent leaks developed, and it was noticed that those pipes which were placed near electric street railway tracks seemed to be attacked to a much greater extent than those which were far removed. Pipes located near power stations were particularly susceptible. It was later found that stray currents were using the pipes as a short cut return to the bus bars at the power station, and in doing so abstracted a part of the iron.

The effect of direct current is discussed since alternating current has a negligible deteriorating action. In order that a current may flow it is necessary to have a difference of potential, moisture, and an electrolyte, such as salt. Since practically all soils contain electrolytes and moisture, it follows that when pipes are buried in moist soils and a difference of potential exists between the soil and the pipe, or between the rail and the soil, a current will flow through the earth and enter the pipe provided the resistance of the rail or of the earth is greater than that of the pipe.

No damage will result to the pipe as long as the current is on it, but when it leaves the pipe, it dissolves a certain amount of iron which is directly proportional to the amount of current leaving the pipe. This is equal to 0.00029 grams of iron per ampere per second, or a little more than 20 lb. of iron if a current of 1 ampere flows continuously from the pipe for a period of one year. The same amount of current will dissolve or corrode about 74 lb. of lead in one year. Current may enter and leave the pipe several times, in which case the action is increased. The current leaves the pipe at certain points, because the moisture and the electrolytes in the soil at that point make better contact wih the pipe and thus furnish an easier mode of exit for the current. This accounts for the "pitting" or the dissolving of one section of the pipe while another portion of that same pipe, quite near to the damaged part, is unaffected. The solution of the iron first manifests itself on the outside, and proceeds in the shape of a cone extending towards the center.

Under the action of the current, the iron first goes into solution and then reacts with the moisture present in the soil, forms a hydrate of iron which latter undergoes further change, and the final result is that there is found clinging to the outer surface of the pipe, and extending towards the negative pole, a hydrated oxide of iron. These electrolytic hydrated oxides of iron are different in physical properties and chemical composition from ordinary iron rust and an examination of the corroded specimens furnishes one of the methods by means of which electrolyzed pipe may be differentiated, with certainty, from pipe which has been damaged by ordinary corrosion.

It has frequently been stated that in order to cause damage to pipes the difference of electrical pressure between pipe and rail must be at least equal to the "decomposition voltage" of electrolytes occurring in the soil. Such assertions are contrary to experience, and it has been clearly demonstrated that it is the solvent action produced by the current which is repsonsible for the damage. A slight difference of electrical pressure may be accompanied by a considerable flow of current while a greater potential between rail and pipe may be accompanied by a much smaller flow of current.

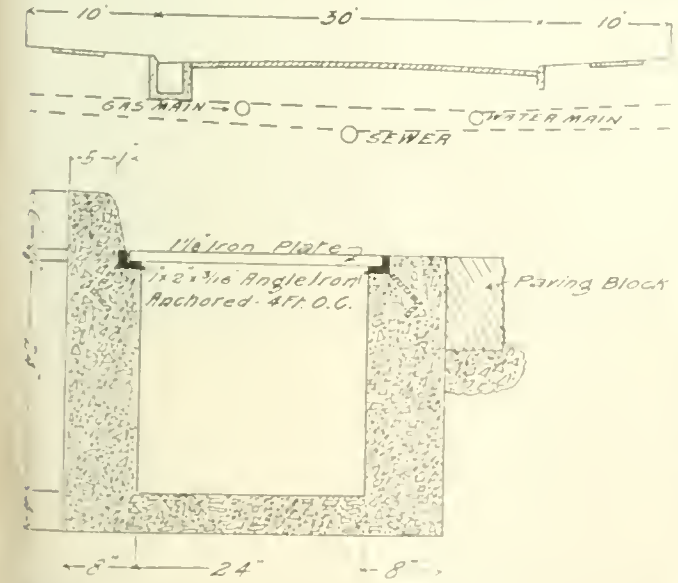
Results which the writer obtained when attempting to determine the relative action of the current on pipes subjected to the action of various electrolytes and various electrical pressures indicated that the low differences of potential, during the flow of current have as much influence as much higher differences of potential if accompanied by the same flow of current.

Iron pipes when electrically negative are not corroded by the current, but the assumption that metals when electrically negative are immune under all conditions is incorrect. For instance, lead pipes are corroded when electrically positive and, under certain conditions, are also corroded when they are electrically negative. In the first instance the lead is dissolved by the current, and when electrically negative they may be attacked by products resulting from the action of the current. Lead water pipes should be electrically neutral.

Upon first consideration, it seems strange that an electrically insulating substance such as a pipe dip should not effectively protect a pipe against electrolytic corrosion. On close examination it appears that the hydrocarbon substances constituting the "dip" are oxidized by the oxygen set free by the current and the material at that particular point is converted into a porous substance and no longer is able to electrically insulate the pipe. The action is not brought about by a "break down voltage" but by the slow or rapid absorption of oxygen and the oxidation of the hydrocarbons constituting the dip. This action is especially rapid when the dips are made of coal tar products which contain electrolytes, unless the "tar acids" have first been completely removed.

Storm Water Sewer Combined with Curb and Gutter

The interesting design illustrated below was used for a storm water sewer at West Orange, N. J. The sewer discharges into a branch, the flood height of which is about 21 in. below the surface of the street. Owing to this fact and to the sanitary sewer, gas and water mains and the house connections in the street it was impossible to install a storm sewer in the usual manner. The problem was solved by combining the storm sewer with the curb and gutter; the sewer is about 500 ft. long and serves a considerable drainage area, all streets of which are paved and which carried the storm flow in this gutter. Before the installation of the sewer an ordinary rain of one day rendered impossible the street in which the sewer had been installed. The sewer has been in service about 8 months and has given excellent service. The cost of the work was $5.55 per lineal foot. The sewer was designed and built by Charles A. Winston, Town Engineer.



California Irrigation Act Unconstitutional.—The California Irrigation Act of 1919 has been declared unconstitutional by the State Supreme Court. The court held that the act was unconstitutional because it is not uniform in operation, districts in the Counties of Los Angeles and San Bernardino being exempted from the jurisdiction of the Irrigation Board of California, a body created under the act to centralize control of irrigation districts.

Measuring Upward Pressure on Dams

Investigations to determine the hydraulic gradient of seeping water though gravel under a dam have been made by engineers of the Miami Conservancy District of Dayton, O. The test apparatus was made of a series of 1-in. gas pipes built into the concrete of the dam as the latter was constructed, extending from various points at the lower surface of the dam up through it to the air above, the lower ends being open but tied round with a burlap bag of coarse gravel to prevent clogging. See Fig. 2, where the lower ends of the pipes are numbered "1," "2," "3," etc., and the bags are indicated. At the upper end each pipe terminated in a short vertical length open at the top. For convenience all the pipes were led through the structure to the flat apron below the dam crest, where the upper ends were easily accessible. Remembering that the water, which is flowing at all times over the dam crest, is also seeping slowly through the saturated gravel beneath it, it will be seen that the seeping water will rise in each pipe till it reaches a height sufficient to balance the pressure under which it is flowing at the pipe's lower end. This height can be easily measured by inserting a stick in the open top of the pipe till it reaches the water surface. The pressures will vary with the heights of these water columns in the several pipes. The greatest will naturally be at the upper edge of the dam, at "10," where the pipe might naturally be expected to be subjected to the full head of water above the dam. The least will be at "1," next the tail water below the dam. Intermediate points will give the pressures just below and just above each fence of sheet piling, and each cut-off wall; and in the middle of the long level space at "2." Having the measures at these points, we have determined thus by actual test whether the creep or the water under the dam corresponds with the theory outlined above.

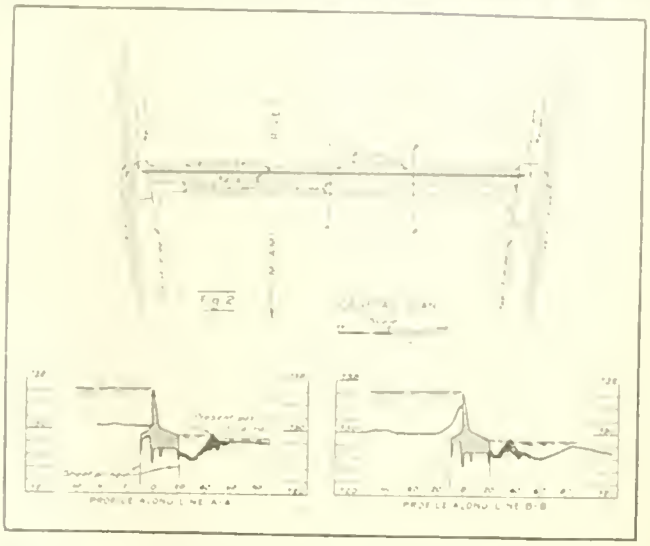


Fig. 1.—Plan and Profile of the Dam.

The Structure is an Overfall Dam of Concrete, with Gravity Section. The Test Pipes Were Installed Along Lines AA and BB. The Foundations are on Sand and Gravel with a Slight Intermixture of Clay.

The heights of the several water columns in the pipe "1," "2," etc., are indicated by the small circles "a," "b," "c," etc. (Fig. 2), immediately above those points, as measured during the tests. Several measurements were made in each case, with very closely corresponding results, assuring that the small circles give the actual pressures at the lower ends of the pipes. In some cases two small circles are seen, these indicating the extreme limits in the measures, due to slight differences in conditions. By joining the small circles by a line (the "hydraulic gradient"), a diagram is obtained of the drop in pressure under which the water flows, as it seeps from the upstream to the downstream limit of the dam, through the gravel. Two lines are in fact shown in Fig. 2, a dotted and a full line, corresponding to the slight differences in the measurements. They are so close together that they may be considered as one.

It would naturally be expected, since the pipes open below into porous gravel, that the pressure at "10" would be equal to the full depth of the water from "10" up to the surface of the water flowing over the dam. In fact, this pressure is only that from "10" up to the small circle at "k." The reason for this is that the pipe at "10" was protected from the full pressure of the water above it by a blanket of mud which had been deposited on the bottom of the pond above the dam during the period between the building of the dam and the taking of the meaurements, this period being about two years. This mud blanket was from 2 to 6 in. thick. It "plugged" the porous gravel, to a great degree, stanching the seepage flow. The head of the water above "10," from the surface down to the small circle at "k," was occupied in forcing the water through the mud blanket, leaving only the drop along the piezometric line, from "k" to "a," to force the water through the gravel beneath the dam.

It is to be regretted that the measurements of pressure could not have been made immediately after the dam was built, thus furnishing a means of comparing conditions when the porosity and seepage were greatest, with those existing after the mud blanket formed. In fact, the dam being built in 1917, the active entry of America into the war made this practically impossible.

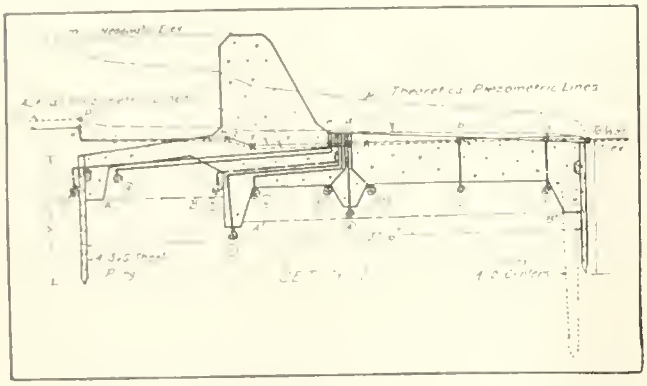


Fig. 2.—Section Showing Pipe Installation Along Line AA.

Nevertheless, the measures do tell something as to the theory used in calculating seepage flow without a mud blanket, the piezometric line, indicating the drop in pressure forcing seepage along the under side of the dam, according to this theory, is shown running from "m" to "n." With the blanket, according to theory it is the line "p" to "n." Actually, as measured, with the blanket, it is the line "k" to "n." The discrepancy is manifest. The theory is not backed by the facts in this case.

The greatest value of these experiments is in the proof they supply as to the efficacy of an upstream blanket of mud and silt in reducing the upward pressure acting to endanger a dam, when built, as dams must sometimes be, on porous strata. The proof came when the mud blanket next the pipe at "10" was removed, and the full water pressure allowed to reach that point. This was accomplished by lowering a fire hose nozzle under about 75 lb. pressure under the water, and directing the issuing stream against the mud at the bottom, washing it away and permitting direct pressure to reach the pipe end. The water in the open end of the measuring pipe on the dam apron immediately rose to practically the level of the headwater above the dam crest.

It was notable, however, that the water level in the other pipes was not affected by the change. This was to be expected. The area of pond blanket cleaned away by the nozzle was apparently small and the flow through it was diffused. In any case, the efficacy of the mud blanket itself was demonstrated beyond doubt, and points to the desirability of the introduction of this feature (by means of rolled fill or otherwise), as an additional factor of safety in dams built on porous material.

An interesting feature of the investigation was the discovery that considerable quantities of gas were accumulating beneath the dam, especially at the end of the pipe "9," where the shape of the under surface caused it to act as a gas holder. "In a period of about a month between observations gas had collected so that the flow from a ¼ in. nipple connected with this pipe was sufficient to maintain a flame about a foot high for 10 minutes. The gas was evidently methane, generated by the decomposition of slight quantities of vegetable matter in the gravel." This gas evidently increased the tendency of the dam to float—that is, increased the upward pressure on its bottom; a fact which should be considered in some cases in dam design.

The investigation was carried out by E. W. Lane, Assistant Engineer with the District, and E. L. Chandler, Assistant Division Engineer on the Miami River improvement through Dayton. In the original installation of the apparatus in the dam, Mr. Lane collaborated with B. M. Jones, whose transfer to be Division Engineer at the Lockington Dam made his further participation in the enterprise impossible.

We are indebted to the Miami Conservancy Bulletin, the official publication of the district for the above information.

Cost-Plus Contract for Impounding Dam at Decatur, Ill.

The city of Decatur, Ill., has recently let a contract for an impounding dam on a cost-plus basis, the details of which may be of interest. Four bids were received for the entire project as scheduled. The highest bid was on a unit price basis for $1,101,000, and the lowest was a cost-plus bid by L. N. Cope & Sons, Decatur, with a minimum and maximum limit. The dam is to furnish additional water supply for the city and is located on the Sangamon River. It was described in Engineering and Contracting, Feb. 11, 1920.

The principal features in the contract are the methods of compensation for the contractor. Under the terms, the city agrees to pay the contractor the actual net cost of the work, including all materials, labor and supplies, and in addition a lump sum of $20,000 to cover plant charges, including all machinery, tools, and equipment, and a fee of 10 per cent of the actual net cost.

The actual net cost shall be taken to include the actual cost of all materials, supplies, labor, insurance, surety bond, and field office expense, after deduction has been made for salvage. All of these costs are those which it can be shown have been actually incurred by the contractor.

Upon the completion of the work all salvage material shall be placed by the contractor in a saleable condition on the ground and shall be offered for sale by the city within 30 days. All unused material and supplies in usable condition shall be removed by the contractor who shall pay the original cost to the city. The amounts received by the city for salvaged and unused material shall be deducted from the actual cost of the work in determining the actual net cost upon which the fee is based.

The fee of 10 per cent compensates the contractor for all overhead or other expenses in this main office, including bookkeeping, accounting, purchasing, contractor's drafting and other miscellaneous expenses; all interest on loans during construction, and all profit.

The lump sum of $20,000 for plant charges shall cover the use, rental and depreciation of all machinery, tools and equipment, together with all freight charges and the expense of erection, knocking down and shipping away. This does not include any cost of concrete forms, concrete towers, material bins or sheds.

For the purpose of computing a fee, a schedule of quantities taken from plans and prices were agreed upon as the estimated base value of the work exclusive of profit, overhead or plant charges. This base price is $700,000.

Additional agreements state that if the actual net cost is greater than the base value, the contractor receives 10 per cent of the base value, with a deduction therefrom of 20 per cent of the cost in excess of the base, provided that the total deduction does not exceed 50 per cent of the 10 per cent.

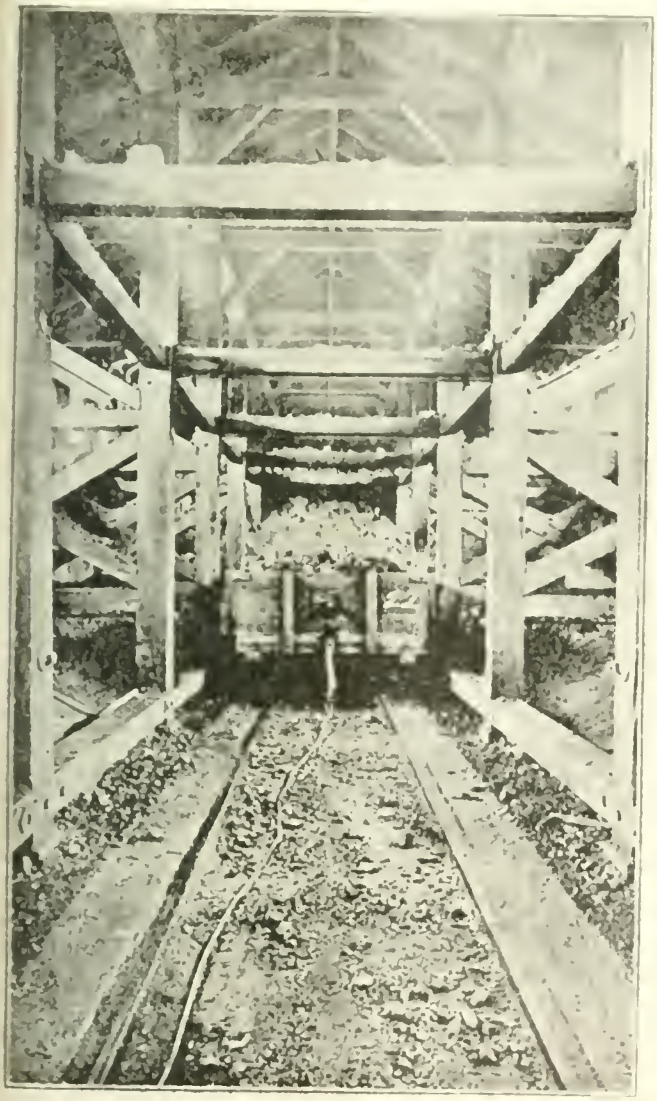
If the actual net cost is less than the base value, then the contractor is to be paid as his fee the sum of 10 per cent of the base, with an additional 20 per cent of the difference.

In no case under the terms of the contract shall the contractor be paid more than a total of $975,000, unless plans and specifications are altered.

The work is under the direction of Pearse, Greeley & Hansen, Consulting Engineers, Chicago, with J. Albert Holmes as Resident Engineer. W. J. Collins is City Engineer.

Coal Storage at St. Louis Water Works*

The Water Department of St. Louis is provided with a coal storage capacity of 15,400 tons, enough for 60 days' operation of the works. Three remote storage sheds are maintained, one at Bissell's Point, one at Humboldt avenue and one at the Chain of Rocks. The accompanying illustration shows the interior of the Bissell's Point shed. Some interesting information regarding the St. Louis experiences in this work were given by Mr. L. A. Day, engineer in charge, operating section, in a paper presented at the recent convention of the American Water Works' Association, from which we quote as follows:



Storage Coal Shed at Bissell's Point, Showing Low Dump Cars Used to Remove the Coal.

Although we are close to the Illinois coal fields the wisdom of maintaining this liberal supply for emergency use has manifested itself on several occasions since the beginning of the war.

The coal stored is known as 6-in. screened lump. It is piled 15 to 18 ft. high in sheds. We do not attempt to store Illinois screenings for any length of time but have stored for a year Illinois screenings that contained about 45 per cent of duff coal that will pass through a screen having ¼-in. circular perforations. This coal showed no signs of heating after being placed in a pile about 6 ft. high in the open air, with no protection from rain or snow. In general, it has been our experience that all bituminous coal free from fines or duff can be stored for an indefinite period without appreciable heat loss. Heat value determinations show no appreciable heat loss due to storing for ten years. Naturally coal loses some of its moisture. This tends to compensate for the heat loss due to some of the volatile gases being set free.

It is preferable to choose [illegible] lump coal for storing and the coal should be placed with the idea of minimizing breakage.

Water Power Resources of the World*

By SVANTE ARRHENIUS

During the unhappy situation created by the World War, when there was a great scarcity of fuel, and even now, when fuel is extremely expensive, waterfalls were and rapidly are being put to use. Within a short time, therefore, this source of energy will be taken into the service of man not sensibly diminishing the demand for coal. An estimate of the power of the waterfalls has been made by Koehn and by Keplan, and is of much interest. Although the figures are only approximate, I give them in the following table, with some later corrections:

TABLE—WATER POWER RESOURCES OF THE WORLD

	Hp. in million	Hp. per inhabitant.
Asia	226	0.27
Africa	160	1.11
North America	160	1.17
South America	94	5.25
Europe	[illegible]	0.13
Australia	30	3.[illegible]5
Total	[illegible]15	Average 0.45
Canada	26	1
United States	100	1
Iceland	2	22
Norway	13	5.2
Sweden	6.7	1.2
Finland	2.6	0.8
Balkan countries	10	0.6
Switzerland	1.5	0.4
Spain	5.2	0.26
Italy	5.5	0.15
France	6.0	0.15
Austria-Hungary	6.2	0.12
Germany	1.43	0.02
Great Britain	1.0	0.02
Russia	3.0	0.02

These figures are not altogether reliable. Thus, for instance, Leighton gives for the United States 200 millions, and Van Hise says: "Others regard this estimate as too high, and say 100 million horsepower is nearer to truth." I think this latter figure is more to be depended on. Van Hise is of the opinion that even it will meet the needs of a population of 250,000,000. Since his estimate made in 1910 the demands for power have greatly increased, and probably only about one-half of the energy given in the table above is available at present without excessive initial expenditures. We may, therefore, assume 0.5 HP. per inhabitant as adequate to present needs.

We find then that Europe and Asia are the only parts of the world where water power is really scanty—in Asia the demand is still so small that even this power per inhabitant is more than sufficient. Especially fortunate are those countries, such as South American Republics, and Australia where water power per unit of population is well beyond this figure, and may be developed at a moderate cost.

The United States is among the great powers very well endowed in this regard, as in most other natural sources of wealth, such as metal, ores and coal. In Europe, Iceland ranks first, because of its small population, and the old Saga Island may yet know a new and flourishing era. Then come the Scandinavian countries, the first being Norway, which has already greatly profited through its cheap power, and is destined to be one of the leading industrial countries of the future. Sweden and Finland possess enough power for their needs. Their waterfalls are not high, and in general are far from established lines of communication, especially from those of the ocean. Denmark has scarcely any water power, as also Holland.

Among the other countries of Europe the Balkan States have more power than their industrial needs require. Switzerland may also be regarded as having a nearly sufficient supply of water power, which is the more fortunate, as this highly industrial country does not own any coal deposits. The same is true of the new Austria, which has lost its old coal districts but has retained by far the greater part of the waterfalls of the old Austria, so that it now probably ranks with Switzerland in this respect. Spain is also a relatively well situated state, but which up to the present has not made much use of its resources.

---

*From a paper presented May 19 before the Franklin Institute.

In general, the waterfalls in the Alps, Spain, Italy and the Balkans are high and of great value. For the industries of France and Italy water power is of the greatest importance, although it must be regarded as insufficient for nations so highly developed.

At the end of the list come the three great powers of Great Britain, Germany and Russia, with only a fiftieth horsepower per inhabitant. Russia is an agricultural country with a very small demand for power, and agriculture will undoubtedly remain its chief industry because of its small power of resources, both in coal and water. England and Germany, now the most highly developed industrial countries in the world, will undoubtedly also, in the future have agriculture for their chief industry. Probably a great part of these countries will again be covered by forests, as they were in the time of Tacitus.

Laboratory Work and Water Waste Detection

In an informal discussion on Water Waste Control before the New York Section of the American Waterworks Association, Dr. F. E. Hallo, Chief Chemist, Bureau of Water Supply of New York City, described how the laboratory division of a Water Department could be of considerable assistance in detecting water waste. He said:

Some 300 or 400 samples of water a year are collected from cellars, conduits and excavations and sent to the laboratory of the Bureau of Water Supply for analysis. In many instances it is possible to tell whether or not the sample is from the city water, and in some instances to say whether it is Croton water or Catskill water. The waters are naturally divided into three main groups: city supply, sewage, and ground water or unclassified. The most important determinations are the physical character of the water, particularly odor, the microscopical examination, and the chemical analysis for free ammonia, albuminoid ammonia, nitrate, chlorine, hardness and alkalinity. Frequently it can be definitely said that the sample is sewage, and sometimes definitely that it is ground water. In many instances there are intermediate analyses which do not permit of a definite statement, since water in passing through the soil and concrete walls frequently becomes contaminated to such an extent that its character is utterly changed.

In those instances where the information is definite, it is very definite. For example, if there are microscopic organisms present in the water, it must be either city supply or sewage, no matter what the other determinations show. If it is sewage, there is additional definite information furnished by high figures for free and albuminoid ammonia, chlorine, and frequently an alkalinity which is higher than the hardness; nitrate would be low or absent; the odor is distinctive. Frequently samples upon shaking will produce foam due to the presence of soaps. True ground waters are usually high in nitrate, although the latter may sometimes be reduced to cause a high free ammonia. Such samples usually contain considerable chlorine and hardness and very little free and albuminoid ammonia. The following table shows conclusions reached from the analyses of 362 samples of cellar water, etc., submitted during the year 1919:

	No. of samples		Per- centage.	
City water*	70		19	
Probably city water	29		8	
Possibly city water	39	138	11	38
Sewage	36		10	
Probably sewage	7		2	
Possibly sewage	3		1	
House drainage	2		..	
Trade waste	1	49	1	14
Not city (unclassified)	35		10	
Probably not city (unclassified)	134		36	
Ground water	3		1	
Salt water	3	175	1	48
Total		362		100

*3 Croton; 3 Catskill

It is evident from the above that the Laboratory Division is of considerable assistance in indicating whether it is necessary to dig for a leak.

Benefits of Chemical Control of Small Filter Plant*

By KENNETH HOLADAY.
Chemical Engineer, Central Illinois Public Service Co., Mattoon, Ill.

One of the water utilities owned and operated by the Central Illinois Public Service Co. is located at Harrisburg, Ill., and includes a mechanical filtration plant of 1,000,000 gal. daily capacity. Although the raw water at this plant is very difficult to purify, no remarkable problems have been experienced nor have any new ideas of filter plant operation been developed. Only the tried methods of directing purification by laboratory tests have been followed. Since laboratory work is not applied rigidly, if at all, in many filter plants of this size, a comparison of the results obtained before and after the institution of this work as an aid to operation may be interesting to superintendents directing other small filter plants.

The Harrisburg plant was built in 1915. Although it is poorly arranged, none of the poor results obtained can be attributed to the type of the plant or its arrangement, except in so far as a poorly arranged plant is conducive to neglectful operation. But since the water is especially difficult to purify, and the operators have been men of no technical education, and no means of chemical control were provided, it is not surprising that, prior to the fall of 1919, the results were discouraging. The raw water is pumped from the Middle Fork Saline River, which is a small stream carrying the mine wastes of the coal mines of that district. Except during flood seasons, the water is very hard, high in sulphates, and often contains free acid.

Early in 1919 it was determined to secure satisfactory purification of this water if possible with reasonable effort. An inspection showed that there were no means of accurately determining either the total pumpage or the amount of chemicals applied. Much alum and some lime were used as coagulants. The lime was applied in suspension, but was agitated in the tanks only at intervals and by hand, so that the actual dosage was very irregular. No laboratory tests were made whereby the amounts and proportions of coagulants could be determined. The operator used his own judgment as to the addition of the coagulants necessary to clear up the water. Consequently, the water was not always cleared. Most of the turbidity was removed, but the nature of the water is such that there was often a very difficultly removed residual turbidity which gave the appearance of a collidal solution. The amount of alum used was excessive, and rendered the water unfit for laundering without softening. It also increased the natural tendency of the water to corrode pipes, meters, and fixtures. If one attempted to wash his hands in the water during almost any period between flood and low water when both the turbidity and concentration of mine wastes were fairly high, the excess alum would coagulate with the soap, forming a sticky film, which, when dry, produced a very harsh and most unpleasant feeling. The corrosive properties of the water caused much pump trouble, and large losses through dead meters and leaky fixtures. Since poor success tends to neglect rather than care, frequent interruptions occurred for various reasons, all fundamentally due to carelessness.

After thorough inspection of conditions at the plant, it was decided to extend the practices of large scale operation to this small plant as far as possible, especially with regard to recording operating conditions by means of laboratory tests.

An electrically driven stirring apparatus was arranged to agitate the lime solution so that the dosage would be regular. Depth gages were placed on all solution tanks. A recording depth gage was provided to measure the raw water flowing over a weir into the plant. The laboratory, which had been bult in the plant, was equipped for making tests of turbidity, color, alkalinity, free carbon dioxide, and chlorides, bacterial agar counts, and gas former tests. The chief operator of the plant was instructed in the manipulation, purpose, and interpretation of the tests as set forth in a set of specially prepared, detailed instructions. Standard solutions and bacterial media were shipped to Harrisburg from the laboratory of the company's Lawrenceville plant. It was later found more convenient to have the Harrisburg operator prepare his own media. He has been able to interpret intelligently the results of the laboratory tests, and he attributes his success in improving the quality of the filtered water largely to the information they have furnished.

---

*Paper read before the Illinois Section of the American Waterworks Association.

Charts showing the relation of turbidity to the amount of alum necessary for purification were found very useful in determining the dosage of alum. The dosage of lime is regulated by the alkalinity of the raw water, and the amount of alum applied.

The water is still rather hard, but not so much so as to be very objectionable. The laboratory work has shown the operators what an interesting process water purification is, and has made the operation of the plant sufficiently interesting to them so that it no longer seems a hardship to be constantly alert.

The changes in operating methods and means of controlling and recording the purification processes, as mentioned, have been in full force only since last September, so that it is not possible to say that the difficulties of the summer season, when the mine wastes furnish practically the only flow in the stream, have been overcome. Yet the nature of the impurities is the same throughout the year, only modified in the different seasons, and the improvement in the quality of the filtered water of last winter over that of previous winters has been so encouraging that there is little doubt that proper attention to the tests and vigilant operation according to their results, such as is now practiced, will successfully purify the water which flows through the creek in any season.

In the large plant, close chemical control is obviously a necessity, because it not only insures the continuous production of water of a good physical and sanitary quality, but also effects an appreciable financial saving by reducing to a minimum the amounts of coagulants and sterilizing agent applied, and affords an accurate record of production, which is as necessary to a successful water supply business as to any other manufacturing enterprise. In the small plant, treating 1,000,000 gal. or less daily, these several advantages of chemical control are not, theoretically, of sufficient importance to warrant additional investment in equipment and supervision necessary for daily chemical and bacteriological examinations. The experience with the Harrisburg plant, however, has convinced the company that there are other losses than the wasting of a few pounds of chemicals per day, losses due to irregularities of plant operation, which might be eliminated by laboratory control and which accumulate rapidly enough to waste the price of a laboratory in a very short time.

Precipitation Rates at Pawtucket, R. I.—The maximum rates of precipitation of all storms at Pawtucket, R. I., having a rate of 0.75 in. per hour or more in the years 1902 to 1919 inclusive are summarized in a table in the report of the Board of Public Works for the year ending Dec. 31, 1919. The following tabulation shows the average maximum and minimum rates for the above years:

RATE IN INCHES PER HOUR FOR INTERVALS OF MINUTES

	Average.	Maximum.	Minimum
5	4.22	9.07	2.21
10	3.35	5.20	1.15
15	2.83	4.35	1.24
20	2.41	4.34	1.14
30	1.97	3.31	0.86
40	1.67	2.92	0.72
50	1.45	2.35	0.61
60	1.26	2.00	0.59
90	0.96	1.59	0.47
120	0.80	1.18	0.33
180	0.59	1.36	0.27

Comparison of Precipitation Collected by Various Types of Gages.—The following figures from the 1919 report of the Board of Public Works of Pawtucket, R. I., gives an interesting comparison of the precipitation in that city as recorded by several types of gages:

1919.	Standard pail gage, per cent.	Friez gage, per cent.	Automatic gage, per cent.
April	100	97.7	96.9
May	100	102.1	92.2
June	100	98.0	102.6
July	100	97.0	100.7
August	100	99.7	96.4
September	100	97.3	91.8
October	100	95.3	96.4

Comparisons are not made for the months in which snow fell, for a correct record of snow-fall cannot be obtained from the snow usually caught in the gages.

Fly and Mosquito Elimination Work in New York City*

By JOSEPH M. LONERGAN,
Supervising Chief Inspector, Department of Health,
New York City.

The New York City Department of Health accepts the general proposition in its anti-fly measures that prevention of breeding is the keynote to fly extirpation. Consequently elimination or control of the breeding places is the end desired rather than recourse to fly trapping or fly swatting, although these latter agencies may supplement the former under normal conditions of fly appearance.

Experiments show that the fly breeds more readily in horse manure than in any other media. Stable refuse from its deposition within the stable to its final disposal has become the first objective. To attack this problem properly required a knowledge of the location and type of stables within the city limits. Surveys made at stated intervals give the desired information.

Horse manure under normal spring and summer conditions is fly blown within 15 minutes of deposit. This means, according to Howard, that at each setting an average of 120 eggs is laid. In from 8 to 24 hours these eggs hatch out into larvae—the whitish maggots which crawl around the pile. In from 4 to 5 days these change into pupae, reddish brown, egg-shaped cases from which the full-grown flies appear in from 3 to 10 days longer.

Regulations for Stables.—Recognizing the stable as the primary source of our fly population the Board of Health has enacted a section of the Sanitary Code requiring all stable owners to procure permits for the maintenance of stables and compelling them to comply with certain regulations adopted in pursuance of the authority conferred by this ordinance.

The Department of Health insists on thorough cleanliness of the stable, early removal of all stable refuse and the daily flushing with water of racks, stall and stable floors, gutters, valley drains, etc. It recommends that the floors of horse stalls and stables be of concrete since fly larvae find it very easy to burrow into an earth floor, or to secrete themselves in cracks in a wood floor. Concrete floors can be swept broom clean and properly flushed down while earth or wood floors do not permit of a thoroughly good cleaning or flushing. Pending removal of manure it sanctions the use thereon of borax or hellebore, but discourages the use of lime. The latter course is taken as a considerable number of our stable owners in the closely built up sections of the city do not give the time or attention required to thoroughly clean their stables but depend on a liberal use of lime to prevent fly breeding. This procedure has given rise to complaint by neighbors since the use of lime on manure appears to free ammonia with a resulting nuisance of odor.

Manure Bins and Disposal of Stable Refuse.—The use of manure bins or pits in the city is forbidden since these are rarely thoroughly cleaned and fly breeding takes place in the unclean corners. There is one exception to this rule. It is in the case of a stable maintained by one of the large milk companies on the second floor of its building. This bin has tiled sides with a concrete floor sloping sharply to a 24-in. opening controlled by a valve. The wagon for removing this manure drives in on the first floor beneath the bin, the valve is opened and all manure slides out. There is a sewer-connected drain in the concrete floor of the driveway beneath the bin and when the loaded wagon departs the inside of the bin is thoroughly flushed with water from an adjacent hydrant. Numerous inspections of this bin failed to disclose any fly breeding.

The U. S. Department of Agriculture recommends a bin constructed of tight materials with small openings on top covered with close fitting fly screens. These openings will admit light and the flies attracted there will be caught in the traps. The Department of Health maintains that no manure should be allowed to remain in a stable to breed flies and that when these bins are opened to receive fresh manure the flies within will escape. The abolition of bins and the daily removal of manure or the packing of manure in metal covered receptacles from which the larvæ cannot escape to the ground, and the removal of this manure every third day will prevent fly breeding—the end desired.

---

*Abstract of a paper presented March 24 before the Municipal Engineers of the City of New York.

In order to secure the proper removal of stable refuse all persons engaged in the business are placed under permit and required to comply with certain regulations. The more important of these requirements direct that the vehicle used be sound and tight, that it be loaded within the stable and that it be properly covered with a suitable cover to prevent material therein from dropping to the street. These men are required to deliver this material to dumps within the city operated under permit or to farms within the city; supervision at these dumps discloses the stables from which old manure is coming resulting in inspections of such stables with the filing of the necessary violations to remedy the conditions found.

These dumps are along the water front or in railroad yards, the location in each instance having been approved by the Board of Health. At the former an inclined runway leads to a platform overhanging the water. The manure in wagons is carted up to these platforms and dumped upon the scows or into cars on floats which are then towed from the city. To prevent material from the carts dropping into the water aprons of wood or canvas between the dock and floats are provided. These platforms and surroundings are cleaned daily at the completion of the dumping.

At the railroad dumps the tracks are raised on chair cradles, the tie depressed, the ground space between and at both sides of the tracks cemented and this even surface graded to discharge into drains which are sewer-connected or which discharge overboard. A water-supplied hydrant and hose are provided. The cement surface beneath and around the cars is swept at the end of the day's loading, the manure removed and the space thoroughly flushed. The railroad companies provide the cars and the material is forked from the carts thereon. At the time of ordering the concreting of the surface of these dumps neither the railroad companies nor the manure contractors would bear the slight additional cost of depressing the tracks and constructing elevated dumping platforms. The saving in time and labor and the increased efficiency and economy of handling in the method suggested of dumping the carts from elevated platforms over the present method of forking the contents to cars would have well merited the slight additional expenditure.

The use of inland dumps for the storage of manure is not favored, although such dumps may be conducted without any appreciable nuisance if the regulations adopted by the Board of Health be complied with. These regulations require the material to be piled on concrete platforms grading to valley drains which discharge into covered cesspools from which the liquid material may be pumped back over the pile; the manure on these piles to be treated with borax in the proportion of 1 ounce of borax to 1 pint of water to 1 cu. ft. of manure. This treatment, properly applied, effectually prevents fly breeding. After the eggs are hatched the larvæ appear at the outer edges near the bottom of the pile, especially when the manure is wet. By applying the borax to these places or by washing the larvæ into the cesspools, where they drown, fly breeding may be inhibited. In one instance where a concrete platform was not provided beneath the pile living larvæ were found in the ground for a depth of over 2 ft.

Outhouses and Chemical Closets.—Probably the most dangerous places for fly breeding is in the old fashioned outhouse or privy vault. The Department of Health is aware of this and directs its efforts to the abolition of these ancient forms of sewage disposal. Where possible these vaults are ordered disinfected, emptied, cleaned by licensed scavengers, filled with fresh earth and replaced by modern sewer-connected, sanitary, water-flushed fixtures; and as the Department recognizes that fly contact with sewage is a health menace it fosters the construction of sewers and compels the connection of plumbing fixtures thereto as soon as the president of the respective borough accepts the sewer. While the so-called chemical closets are considered makeshift arrangements, still from the fly-breeding and contact viewpoint they have been found to be superior to the old-fashioned outhouse. In the suburban areas where sewer connections are not possible and the privy exists, proper screening of the vault is required in order to prevent fly-breeding therein, or fly contact with the contents. Scavengers cleaning these vaults are placed under permit for the better maintenance of rigid supervision and to insure the proper disposal of the contents free from flies.

Garbage and Street Sweepings as Fly Breeding Places.—Garbage presents an excellent breeding place for flies since the larvæ are insured of an available food supply. Consequently, fly contact with this material should be prevented. To that end the Sanitary Code requires the use of sound metal containers with snug-fitting covers for holding garbage and directs that these containers be kept tightly covered after garbage has been placed therein. At least 100 patented garbage cans containing within themselves some method for holding a disinfectant, have been presented to the Department of Health for inspection and approval These are all easily disarranged and present no advantage over the common can which is scoured, after each use, with a solution of hot water and washing soda.

In the Boroughs of Queens and Richmond the major portion of the garbage, with the papers and rubbish collected, is burnt in incinerators designed for the purpose. Since by this method of garbage disposal the material is consumed before breeding has progressed to any extent, the incineration of garbage occupies a prominent place from the sanitarian's standpoint.

Street sweepings from certain portions of our city, especially from the densely populated sections, contain a high percentage of garbage, manure and other putrescible material. These street sweepings are dumped upon scows with ashes and refuse and used to fill up swamps and low places in the suburban areas. To control fly breeding at these dumps the regulations require that all putrescible material be sprinkled with disinfectant (insecticides) as soon as dumped, and covered with clean ashes or earth. The disinfectant recommended is a solution of formalin. Those in charge of the dumps prefer a patented solution, generally of cresols, which is diluted to such an extent as to make its value questionable. These dumps while eliminating offensive mosquito breeding spots have recently given rise to considerable complaint.

To indifference and to the lack of civic pride in some of our residents must be attributed the condition of a large number of vacant lots, cellars, areas, yards, roofs, etc. In these places are often deposited accumulations of refuse assisting in fly breeding and oftentimes nullifying the work of the district inspectors. Owners, when not guilty of these practices themselves, object to removing the refuse discarded by others and when forced to do so by departmental order or court action become disgruntled at the action of the authorities. It is difficult to apprehend the malefactors in the act but, when such offenders are haled before the courts a goodly fine assists the cause of sanitation.

Educational Campaign.—New York City with its mixed population comprising in its midst people of all grades of intelligence from the four corners of the earth may never expect to be flyless. Realizing this the Department of Health carries on a campaign of education explaining the diseases traceable to flies and the methods recommended for the prevention of fly propagation and for their extirpation. As a first step in such a campaign a knowledge of the fly and its development is necessary. Glass jars containing a banana mixture are prepared and seeded with eggs of the fruit fly (drosophila). These are distributed to each school in the city and placed on exhibition in prominent places. As the fly develops from egg to larvæ, to pupa, to winged insect short talks are delivered to the pupils explaining what is occurring and the methods necessary to prevent such breeding and development. Placards showing the fly winging its way from places unclean to the baby's mouth or food are distributed broadcast. Motion pictures are called into play to depict the fly and its danger to human beings.

As a protection against the adult fly the Board of Health has enacted ordinances regulating the display of foodstuffs upon the street, in show windows and upon store counters to the end that such food products which are not pared, peeled, or cooked before consumption shall be wrapped or otherwise screened from flies. The Department advises the screening of all open windows and doors and all carriages and cribs in which children are sleeping.

Methods of Destroying Flies.—For the destruction of the adult fly the use of sticky fly papers, of a solution of formalin or of a solution of sodium salicylate are recommended. The Public Health Service suggests that three teaspoonsful of sodium salicylate in powdered form be dissolved in a pint of water and placed in open receptacles with a few grains of sugar sprinkled around the edges of the receptacle to attract the fly.

Trapping of the adult fly is an old remedy. Although styles of traps are legion the general principle requires the placing of a fly bait beneath a screen covered cone with a small opening at the apex leading into a larger screened chamber. The flies entering the latter chamber find it impossible to escape and are destroyed by immersion in hot water, etc. The material used as bait is beer, milk, molasses, fish heads, etc.

While the Department of Health refuses to recommend a proprietary remedy it would seem possible in a paper such as this to state the results obtained from the use of one such mixture. The mixture referred to is known as "Shepard's House Fly and Insect Killer," which is applied in the form of a spray. This spray claimed to be noninjurious to mankind, does not stain. The doors and windows of a kitchen, in which a large number of flies were present, were closed and a small amount of the liquid sprayed around the room. In a few minutes the flies began dropping to the floor and within 5 minutes no flies remained alive in the room. The odor of this spray was of the pines and not unpleasant.

According to Howard, flies, their larvae and pupae are destroyed by the common house centipede, by a small mite and by certain beetles and ants. A fungus disease (Empusa muscae) destroys a large number of flies.

For fumigating premises wherein flies hibernate the use of carbon disulphid and carbon tetrachlorid are recommended. However, care in the use of these materials, especially the disulphid is necessary, considering its danger to health and the danger from fire.

Mosquito Control.—The building of the Panama Canal was made possible by the control of mosquitoes in and around the Isthmus. With slight exaggeration along the same line, it may be said that the control of mosquitoes made Staten Island livable. This anti-mosquito work in Richmond Borough was the first definite campaign of that character in the city of New York and was initiated and carried on by Dr. Alvah H. Doty, assisted by Eugene Winship, Sanitary Engineer of the Department of Health.

There are three general classes of mosquitoes. These are the stegomia which transmits yellow fever, the anopheles which acts as the intermediate host of malarial parasites and the culex or pest mosquito of this locality which is claimed to transmit elephantiasis.

The fight against mosquitos is based on the elimination of their breeding places and prevention of their breeding. Measures against them on the wing are of small moment, although fumigation of their hibernating places with carbon disulphid and carbon tetrachlorid while accompanied with a certain amount of danger, is worthy of attention.

The principal seat of mosquito trouble for this city has been the great swampy areas around our water front. In the brackish waters of these swamps the sollicitans or striped-legged, striped-beak mosquito hatched and the adult mosquitoes were blown by the winds to all parts of the city. To secure relief from this pest the ditching of the salt marshes was undertaken by the Department of Health under the supervision of Sanitary Engineer Winship.

Ditching of Salt Marshes to Eradicate Mosquitoes.—Originally the Staten Island marshes were drained by Dr. Doty but these ditches caved in, the sides broke down by horses and wagons crossing them, or outlets were dammed up by boys attempting to catch killies (Fundulus heteroclitus). These marshes were again drained, a total of 1,162,667 lin. ft. of ditches being installed.

In 1915 an appropriation was granted by the Board of Estimate and Apportionment to ditch the salt marshes of the Borough of Brooklyn and Queens. Later the resolution granting this money was altered to include the Borough of The Bronx. By virtue of this resolution the Department of Health entered into contracts for the draining of these marshes and 9,566,767 lin. ft. of ditches were dug at a cost of $0.023 a foot. All marsh lands within the limits of the city have been ditched.

The greater portion of the work on these marshes was done by machine. A gas engine was anchored in the marshes and moved and anchored as the work progressed. Five hundred feet inland, at the beginning of the marsh a knife frame or ditcher was set at the proper level. A chain attached to this frame was wound up on the drum of the engine pulling the frame towards the engine. A tenon of the bog of the required width and depth was cut out and as the frame moved worked up the incline at the rear to drop to the marsh at the side of the ditch thus formed. Men with hooks follow the machine occasionally dragging the excavated material to one side.

This machine operated without a hitch through the tough bog, but whenever the knives struck a sand pocket in the marsh considerable difficulty was experienced often resulting in the disabling of the machine. As the work advanced a watch was kept for these sand pockets and the ditches there cut by hand.

For hand ditching the ordinary spade was used in sandy soil and loose earth. For boggy meadows a slade shovel with a foot rest above it at each side and with a handle from which two hand grips projected operated by two men proved satisfactory.

In ditching a marsh the primary object is not to remove all water therefrom, as ordinarily the elevation of the marsh would render this impossible. By connecting up all holes in the marsh and cutting ditches about 150 ft. apart, such ditches being 10 in. wide and ranging from 20 to 30 in. in depth with main, lateral and circumferential drainage canals, a circulation of water through the marshes is obtained and breeding prevented. The marsh land itself, which was a saturated, spongy mass holding accumulations of water drains into these ditches, leaving the marsh safe to walk over especially at low tide. Subsequent to digging these ditches the farmers in the vicinity of the marshes found it possible to cut salt hay, which is used for packing and which nets them from $8 to $10 a ton. With usual human shortsightedness, these very farmers render the salt marshes valueless by failing to obey the regulations relative to providing boards (bridges) over the ditches across which they drive. The sides of the ditches are broken, water ponds back on the marsh, mosquitoes breed, increasing the cost of maintenance. A similar condition has been caused by gunners blocking the outlets of the ditches in order to form pools of water for swimming holes for wild ducks which they are hunting.

Continual maintenance of these ditches is required. For some time after the ditching and especially until the material excavated has been fastened to the bog beneath it by weed growth, some sods are washed back into the ditches by extremely high tides. These ditches tend to silt up and weeds grow in them lessening their efficiency. For clearing these ditches, a tool similar to a potato hook, though slightly longer and stronger, has given best results. With one of these hooks a laborer can clean out about a mile of ditch a day, unless new cutting be required.

Elimination of Breeding Places in Fresh Water Ponds.—From the health standpoint fresh water offers more danger from mosquito breeding than does salt water. The anopheles or malarial mosquito breeds in fresh water and has been found in many places around this city. For the elimination of these breeding places or for the control of breeding therein different measures are taken, depending on the location of the water, etc.

Where water ponds for a period of two weeks during warm weather a potential nuisance has been established as a crop of mosquitoes may have issued. If this water be in a low spot or in an excavation the simplest method is filling to prevent such ponding. To this end the city of New York has been depositing its ashes, street sweepings and rubbish in these low spots and permanently eliminating breeding. Large areas have been filled by the Department of Street Cleaning, in this way reclaiming waste land to the good of the public in general. Other large tracts have been filled in by material obtained from the digging of subways and cellars and the grading of streets and lots. Large marsh areas have been filled during channel dredging in the waters around the city by pumping the material from the channel to the marshes. In preparation for the pumping it has been customary to build dikes from the sods cut from the meadows. This dike building extends over a considerable period of time and the sod holes form excellent mosquito breeding places unless steps be taken to prevent this. As this pumped material settles and dries large cracks appear across the surface and mosquitoes breed in the water ponding there.

The suburban areas in an absence of sewers depend for their drainage of surface waters upon streams and brooks.

Obstructions and vegetation render maintenance of these streams necessary, as mosquitoes breed in the pockets formed. These streams offer an accessible outlet for water ponding on vacant property when connected therewith by ditches.

Springs or small accumulations of water may be ditched into ponds or lakes where the required fall can be obtained. Large marshy areas may be rendered mosquito free by removing the vegetation, clearing and shearing the sides and stocking the resulting pond with fish. For the purpose intended top-swimming fish, as the minnow, are required, as these eat the mosquito larvæ and pupæ and will keep the pond clear thereof.

Where a sand or gravel bed is adjacent to standing water, or where the removal of the top-soil will expose such a bed, ditching the water thereto will cause it to spread over and seep through the sand or gravel. By digging well holes through the hard strata holding the water to the porous soil beneath the draining of considerable areas is possible. At College Point, L. I., it was estimated that a large area of stagnant water would cost $100,000 to fill. A well sunk there at an outlay of about $300 effectually drained the swamp. As a precautionary measure to prevent the silting up of these wells box drainage heads are generally used through which the water enters the holes.

Oiling for Destroying Mosquito Larvæ. It is necessary for mosquito larvæ and pupæ to breathe. For this purpose they come to the surface of the water at regular intervals. Advantage is taken of this fact to cause their suffocation, as it has been found that oil will effectually clog up their breathing tubes. The oil is spread in a thin film over the surface of the water and in a very short time the water contains no living larvæ or pupæ. While any oil is suitable for this purpose, the Department of Health uses the cheapest grade of oil obtainable.

To apply this oil the use of a 5-gal. watering can with a long rose spray nozzle has been found suitable. The amount of oil to be used depends on the location of the water and vegetation in and around it. However, about 1 ounce of oil is sufficient to cover about 15 sq. ft. of water surface. As this oil evaporates, it is blown to one or the other side of the pond by the wind and as mosquitoes may breed within 10 days under favorable conditions, our oiling squad oils these places at 10-day intervals through the breeding season.

In slow-moving streams mosquitoes are often found breeding near the banks where there is little if any movement to the water. To prevent this breeding and to distribute a steady though slight film of oil to the water a can of oil is anchored near the head of the stream. From this can a wick extends to the stream. Oil dripping from this wick is carried down with the waters and is found to collect around the banks in these sluggish pockets. Throwing oil soaked sawdust or waste into the stream serves the same purpose.

Overflowing, uncovered, or improperly covered cesspools afford excellent breeding places. So do uncovered or improperly covered roof tanks, barrels and other receptacles. Fire pails in factories and theaters in which the water is left without change for any length of time are often found to be the cause of mosquito breeding. Obstructed roof gutters, unflushed catch-basins in parks or outlying districts, bottles and cans on dumps and an innumerable list of places in which water stands offer the mosquito a place to deposit her eggs.

Where water is necessary in fire pails, barrels or cisterns the covering of these receptacles or the screening with fine-mesh screens is required. Overflowing cesspools are required to be cleaned by licensed scavengers and tight covers provided therefor. Disused tanks must be tightly covered or properly screened and all water removed from other receptacles and these so placed as not to hold water.

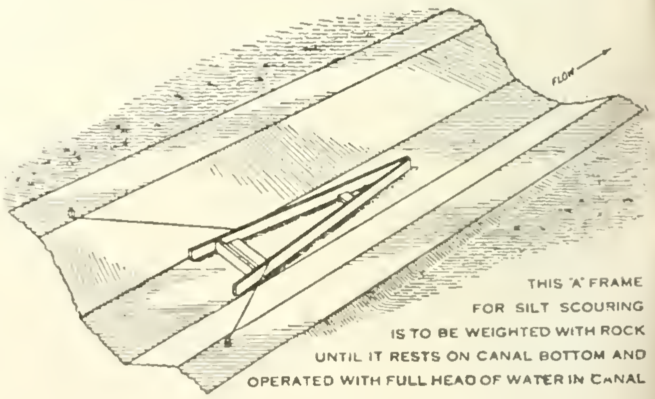
During the construction of the subways it was necessary to remove sewers and replace them with wooden flumes. These were generally defective and leaked into the cut. Mosquitos bred in this sewage and caused considerable trouble until the breeding places were discovered and eliminated. Drip pans are provided beneath the sidewalk grating ventilators of these subways. The floors of most of these pans are beneath the inlets to the drains. Water ponds in these pans for some time after each rainstorm and considerable mosquito breeding has been noted therein.

Keeping the House Free of Mosquitoes. Screening of all windows and doors is the easiest measure to be taken to keep the home free of mosquitoes. If mosquitoes do gain access to the house they generally wait until nightfall to disclose their presence. A cloth hung at the bed after saturation in a mixture of 1 ounce of cedar oil, 2 ounces of citronella and 2 ounces of spirits of camphor, keeps these pests away.

The adult salt marsh mosquito rarely survives the winter. However, the eggs laid in the mud by the last brood of the year surviving the winter hatch out when the water becomes warmer in the spring. The fresh-water mosquito may live over the winter both in the adult and in the larva stage, the latter even reviving after having been frozen during the severe winter. The adult mosquito hibernates in cellars, stables and outhouses to come forth in the spring to perpetuate its race. To rid these places of such mosquitoes the use of carbon disulphid or carbon tetrachlorid under proper precautions is recommended. The use of 5 to 10 cubic centimeters of sulphuric acid poured into a vessel containing about 5 teaspoonsful of chloride of lime is also used as a fumigant.

Device for Scouring Silt from Irrigation Canals

An effective device is used on the canal of the Mapleton Irrigation District, Utah, to keep the silt moving in the upper end of its canal. The arrangement, which is described in the August Reclamation Record, consists of a wooden A-frame which is placed in the canal and loaded with rock until it rests on the bottom. Stay lines attached to the rear end of the A-frame and fastened to the stakes driven in the canal banks, or held by a man on either bank, hold the A-frame in place. The water washes under the A-frame and scours out the silt immediately in front of it and the A-frame settles a corresponding amount. This action continues until the desired amount of silt is scoured from this particular spot and then the A-frame is allowed to move down the canal to a new position, where the scouring action again takes place.


FLOW
THIS "A" FRAME
FOR SILT SCOURING
IS TO BE WEIGHTED WITH ROCK
UNTIL IT RESTS ON CANAL BOTTOM AND
OPERATED WITH FULL HEAD OF WATER IN CANAL

A-Frame for Silt Scouring.

The accompanying sketch shows the scheme used by the Mapleton Lateral Board of the Strawberry Valley Project of the U. S. Reclamation Service to scour the accumlated silt from their main canal during the season 1919. They operated the frame by means of a man on either bank holding the stay lines. As soon as the frame ceased to settle, it was allowed to move gradually downstream.

The A-frame is very effective using it in this manner and large quantities of silt can be removed very cheaply without the inconvenience caused by turning the water out of the canal in order to do the cleaning by the ordinary methods used. In the above-mentioned case 1.2 ft. of silt were removed from the canal bottom by this means.

Land Reclamation in Mexico.—The Mexican government, according to a press dispatch, is planning a number of large land reclamation projects in the near future. Preliminary steps toward construction of dams across rivers and the building of canals and ditches have been already taken. The government has begun construction of a dam across the Yaqui river in the state of Sonora which will create a storage reservoir sufficient to water about 40,000 acres of land.

Cost of Water Purification at St. Louis, Mo.

During the fiscal year ending Apr. 1, 1920, 39,642 million gallons of water were pumped into the basins. To this amount of water were added 1,387 tons of sulphate of iron and 11,753 tons of lime, or an average of 0.49 grains per gallon of the former chemical and 5.21 grains per gallon of the latter. To the 39,092 millions of gallons filtered were added 2,388 tons of sulphate of alumina and 120,187 lb. of chlorine, or an average of 0.86 grains per gallon of the sulphate and 3.07 lb. per million gallons of the chlorine. The sulphate of alumina was added before, and the chlorine after, filtration. The average cost per million for lime was $3.89; for sulphate of iron, $0.67; for sulphate of alumina, $1.92 and for chlorine, $0.29. These costs are for chemicals alone and do not include the cost of handling or application. A comparison of the costs of the various parts of the purification work done during the past five years, based on the quantity of water delivered to consumers, is shown in the following table:

COST PER MILLION GALLONS, BASED ON CONSUMPTION.

OLD PLANT.	1915-1916.	Nov., 1915, to April, 1916.	1916-1917.	1917-1918.	1918-1919.	1919-1920.
Lime	$1.70	$1.61	$1.89	$2.91	$3.72	$3.89
Iron	1.12	.64	.61	.57	.82	.67
Unloading	.08	.07	.08	.09	.12	.12
Operating, Maintenance and Repairs	.47	.51	.38	.41	.60	.59
Water, Coal, Oil, etc.	.03	.04	.03	.05	.08	.05
Light and power	.07	.07	.04	.10	.12	.11
Chemical work	.43	.49	.38	.34	.30	.31
Basin cleaning	.14	.08	.12[1]	.17	.22	.26
Basin repairs	.03	.03	.01	.02	.02	.02
[3]Switching and Demurrage	....	....	....	....	....	.22
Total old plant	$4.37	$3.54	$3.54	$4.69	$6.00	$6.24
FILTERS.						
Aluminum sulphate	$0.76	$1.00	$0.79	$1.13	$1.37	$1.92
Chlorine	.18	.15	.14	.27	.31	.29
Operating, maintenance and repairs	.83	.98	.80	.77	.89	.94
Coal, miscellaneous supplies and expenses	.14	.26	.20[2]	.36	.39	.39
Light and power	.14	.15	.11	.21	.24	.31
[3]Switching and demurrage	....	....	....	....	....	.02
Total	$6.42	$6.08	$5.58	$7.43	$9.10	$10.11
Total consumption for year in million gals.	32,583	13,138	35,633	38,090	36,840	38,004
COST OF CHEMICALS.						
Lime, per ton, average 2 contracts	$ 3.65	....	$ 4.49	$ 6.86	$ 8.75	$10.03
Sulphate of iron, per ton, average	10.00	....	12.50	12.84	16.84	18.48
Sulphate of alumina, per ton, average	....	....	21.00	22.25	27.60	30.49
Chlorine, per pound	.08	....	.13⅜	.13⅜	.12⅝	.09¼

---

[1] Water used in basin cleaning—Omitted prior to 1916.

[2] Water used in filter plant operation—Omitted prior to 1916.

[3] Switching and demurrage in years 1915 to 1918, inclusive, are included in operating, maintenance, repairs, etc.

The complete purification system was not in use until October, 1915. The heading, November, 1915-April, 1916, is included to show the costs of purification after the system was completed. The figures are included for the year of 1915-1916. Under the head of lime, iron, sulphate of alumina and chlorine are included all charges connected with the switching of these materials from the interchange tracks at Bissell's Point and Humboldt avenue to the Chain of Rocks. The sulphate of iron, in the form of sugar sulphate, was furnished at $14.16 per ton after Aug. 1, 1919. The price of $23.50 was in effect prior to that date, but none was brought under that contract after April 1, 1919. Liquid chlorine cost 10.75 ct. per pound until Aug. 1 and at 5 ct. per pound after that date. The prices given are f. o. b. Niagara Falls, the prices delivered being 11.78 ct. and 6.40 ct. per pound. Sulphate of alumina was purchased under the same specifications as last year. Basic sulphate of alumina containing not less than 17 per cent of available water soluble alumina, Al_2O_3, was required. The sulphate was supplied from April 1st to Sept. 15th at a price of $34.50 per ton, from Dec. 15th to Jan. 1st at $30 per ton and after that date at $28.50 per ton. A few cars furnished during September cost $23 per ton. From Oct. 1st to Dec. 15th the sulphate of alumina was supplied at $30.90 a ton. Lime was purchased under a specification requiring a lime containing 85 per cent CaO with a bonus or penalty of 1½ per cent of the contract price for each per cent of CaO above or below the required 85 per cent. All lime was [illegible] after unloading and [illegible] with the samples obtained from the d[illegible] were [illegible] in the laboratory. Lime w[illegible] a ton from April 1st to Sept. 1[illegible] a ton from Sept. 1st to Feb. 1st and at $1[illegible] that date. The above notes are taken from the [illegible] V. Graf, Chief Chemist, Filter Plant, [illegible] the recently issued annual report of Ed[illegible] Commissioner, St. Louis.

Methods and Cost of Making Cement Joints for Cast Iron Water Pipe

In April, 1917, the Spring Valley Water Co. of San Francisco, Calif., laid two sections of 4 in. cast iron pipe, using cement instead of lead in making the joints. This was in the nature of an experiment, none of the men ever having made a cement joint before. The line was thoroughly tested for leakage before being put into use and the results were so satisfactory that cement has been used in some 16,000 ft. of 4-in.; 5,000 ft. of 6-in. and 16,000 ft. of 8-in cast iron pipe laid since that time. No larger size mains were laid during or since the war period; had any such been laid, cement would have been used. Over one mile of these lines has been in use more than two years under 175 lb. pressure without requiring any repairs. The experiences of the company in making these joints has been set forth by Mr. George W. Pracy, Superintendent, in the July Journal of the American Waterworks. An abstract of Mr. Pracy's paper follows:

Making the Joint.—In making the cement joint, the spigot end is put into the bell just the same as for a lead joint. Two rings of jute or yarn are then put around the pipe and driven into the bell in the regular manner. The jute used must be free from oil or tar. In some joints the jute was put in dry and in some it was soaked in grout before being used. There was no apparent difference in the results.

When the jute is in place the cement is mixed. Neat cement of standard Portland Cement brand is used. The mix is very dry, the proportions being about 13 to 14 lbs. of cement to 1 lb. of water. This leaves the mixture so dry that it will crumble readily when handled. At no time should the mixture be wet enough to become sticky. The mixing is done in a pan or bucket, enough cement for one joint being mixed at a time. At first the men guessed at the amounts, taking what cement and water they thought was right. Later, measures were used, calibrated to give the amount of cement and water necessary, including waste, for a 4, 6 and 8-in. joint.

When the cement is mixed ready for use, a canvas is placed under the joint to catch the waste. The operator takes a handful of cement and with an ordinary calking iron shoves the cement into the joint until the joint is full. He then takes a calking hammer and calks the joint until the cement is rammed in as hard as possible. The joint is then again filled and the operation repeated until the joint is completely filled with the rammed cement. At first a bead was put around outside the bell, but this was discontinued as being unnecessary. In handling the cement the men must wear gloves. After the joint is finished, it is covered with earth while the cement is hardening.

Amount of Cement Used.—In putting the cement into the joints, considerable is lost, even though a canvas be placed to catch it. The amount used in making a joint depends entirely upon the carefulness of the operator. In some careful checks made it was found that from 5½ to 10 lb. of cement were used in making an 8-in. joint. On an average, however, a 4-in. joint will take 5 lb., a 6-in. 7 lb., and an 8-in. 9 lb. As cement costs less than 1 ct. a pound, the cost for material is not very great and it does not pay to slow up the men by exacting the extreme of carefulness.

Cost of Cement Joints.—Careful observation on the cost of lead joints made in laying over 45,000 ft. of pipe in 1915 and of cement joints made in laying the 37,000 ft. during the last three years, has resulted in the following comparative table of costs; the wage scales and material prices have been adjusted to meet present conditions:

	Size of joints.		
	4-in.	6-in.	8-in.
Lead joints:			
Labor—Calker at $5.50; leadman at $4.75	$0.527	$0.723	$0.850
Lead—at 9½ ct. per lb.	.831	1.165	1.495

Coal—at $[illegible] per ton	.015	[illegible]	.026
Total	$1.37[illegible]	$1.913	$2.371
Cement joint:			
Labor $[illegible].50 per 8-hour day	$[illegible]	$0.44	$0.58
Cement	[illegible]	.07	.09
Total	$0.[illegible]	$1.51	$0.67
Saving per cement joint	$1.0[illegible]	1.5[illegible]	1.70
Saving per foot for 12-foot lengths	.08½	.12½	.14

The cost of yarn amounting to a few cents a joint, has not been included as it is the same in both cases.

Leakage Through Cement Joints. When water is first turned into the line with cement joints, every joint weeps badly and in some cases the water oozes out quite rapidly. In a few instances small pin-like streams have squirted out. In 24 hours this has practically all stopped and in two or three days the line is tighter than a line with lead joints.

On some jobs a meter was cut in on a by-pass around a closed gate so that the water to replace the leakage from the line was measured. The meter showed a leakage of 100 cu. ft. or more the first day, dropping to a few cubic feet on the second day and practically nothing thereafter.

Four sections of pipe, about 1,500 ft. long, tested for leakage at the joints after the water had been in the pipe for a week, gave the following results: In the first section the leakage was ⅓ gal. per linear foot of pipe joint per 24 hours. The second section leaked so slowly that the leakage could not be measured. The last two sections were practically tight, the line being pumped to pressure and left standing in one case for ½ hour and in the other case 2½ hours without any drop in the pressure.

Flexibility of the Cement Joint.—At San Jose a test section of 6-in. pipe was made, somewhat over 70 ft. long, using cement joints. This was first pumped to a pressure of 300 lb. without any leakage through the joints. The line was then put on supports so that it was elevated about 4 ft. off the ground. With a normal working pressure of 60 lb. on the line, all but the two end supports were knocked out, permitting the pipe to be self-supporting over a span of 70 ft. The pipe dropped 2 ft. in the center without causing any leakage at the joints. The line was then again lowered until it lay flat on the ground, while under normal working pressure; still no leakage. It was then emptied and left empty, exposed to temperature varying from 10° to 110° F. for nearly one year, after which it was again filled and the joints were all found to be tight.

Repairs to Cement Joints.—In the first block of pipe laid, containing about 40 joints, 3 joints had to be cut out and remade. Since that time only 2 joints have continued to leak after the water was turned on. Both these joints were repaired by cutting out only that portion of the joint that was leaking and calking in lead wool. The pressure had to be taken off the line while the work was being done. Cutting out the joints on the 4-in. line took about 20 minutes. No joints in large pipe have been taken out.

One indirect advantage of cement joints is that they act as insulating joints and reduce the amount of current carried by the line. This feature is of particular importance in the larger cities where electrolytic action has done considerable damage. The cement joint increases the resistance of the pipe as a conductor to such an extent that the current carried is negligible.

Operating Expenses of Holland, Mich., Water Department. The following tabulation from the annual report of the Board of Public Works, Abe Nauta, supterintendent, of Holland, Mich., for the fiscal year ending March 15, 1920, shows the unit costs of operation of the water department for the six fiscal years, 1915-20:

COST PER 1,000 GAL. PUMPED.

Fiscal Year.	[illegible]	Distribution.	Commercial.	General.	Undistributed.	Total.
1915	$[illegible]	$0.00514	$0.002[illegible]	$0.00[illegible]73	$0.00209	$0.01665
1916	[illegible]	.00175	.00311	[illegible]	.00299	.05090
1917	[illegible]	.00420	.00316	[illegible]	.00226	.04540
1918	[illegible]	.00370	.00297	[illegible]	.00345	.05741
1919	[illegible]	.00847	.002[illegible]7	.04112	.00384	.05951
1920	[illegible]	.00778	.00572	.00441	.00309	.06379

Industrial Notes

The T. L. Smith Co. has appointed R. [illegible]owen as eastern district manager in charge of the company's eastern offices and warehouse at 50 Church street, New York, N. Y., succeeding W. S. Walker, who has resigned to take up other work in the middle west.

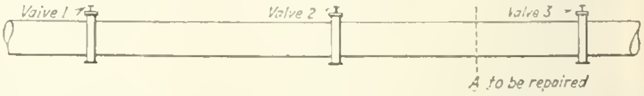
Robert M. Gates has been appointed managing engineer in charge of the Philadelphia district of the [illegible]wood Engineering Co., with offices at 1034 Widener building, Philadelphia. Mr. Gates is a graduate of Purdue University and is at present chairman of the Material Handling Section of the American Society of Mechanical Engineers.

Methods of Repairing Oil Pipe Lines by Oxy-Acetylene Process

The time element is of first importance in the repair of leakage or damaged lines in the West Virginia oil fields, where 6-in. and 8-in. pipe is used and pressure tests range from 800 to 900 lb. Lines of this size and under high working pressure will lose considerable oil if leaks develop. It is often necessary to cut the main carrying lines for the connecting of laterals. This cutting is done much more quickly with the cutting blowpipe than with the old method in which a pipe-cutter was used.

One Wyoming company facilitates its pipe line repairs by installing valves at intervals of from 300 to 1,000 ft., depending on the size of the pipe. Between the valves, alternating with them, are other valves or plugs for use as blow-offs to drain sections on which repairs are needed.

In the illustration, supposing a break or leak occurs at "A," valve 1 is closed, valves 2 and 3 remaining open until most of the oil drains off. (It is not possible to drain the section entirely dry.) Valve 3 is then closed, valve 2 being left open to allow the escape of pressure due to any explosion that may result upon the application of the cutting blowpipe. By manipulating the valves in this way repairs can be made and new sections installed with the welding and cutting blowpipes.



Where it is desired to repair a line not equipped with blow-off valves or plugs the first opening can be cut with a hack-saw so that any flame or gas caused by application of the blowpipe will escape without doing any harm.

Another Wyoming concern, which operates many miles of 8-in. line that is not equipped with valves or plugs, uses oxy-acetylene for repairs by employing a saddle-clamp to make a by-pass around the defective portion, which is then removed and a new section installed, thereby avoiding the necessity of shutting down its pumping station, which might be miles away from the work. Where this method is used it is important that the saddle-clamp and by-pass apparatus be designed by a competent engineer with special reference to the pressure problem involved and that the work be carried on under the supervision of an experienced man who is familiar with the operation and the special conditions with which he has to deal.

Yet another method devised for the repair of an 8-in. line near Caney, Kans., laid some eight years previously and which was leaking badly at a coupling, was to have a vacuum placed in the line by the Caney and Bartlesville (Okla.) pumping stations. The coupling was then removed, the open ends being filled with mud as an added safety feature. The new section was welded in and 800 lb. pressure was restored with satisfactory results.

Personals

S. B. Howe has been reappointed city engineer of Sioux Falls, S. D., and F. J. Connor has been reappointed superintendent of waterworks.

Arthur H. Blanchard, professor of highway engineering and highway transport at the University of Michigan, has recently been appointed consulting engineer to the Michigan State Highway Department.

Prof. Wylie B. Wendt has resigned his position in the department of applied mechanics and machine design at the Kansas State Agricultural College to become professor of civil engineering at the South Dakota School of Mines.

Robert Isham Randolph, consulting engineer, Chicago, is a candidate for the republican nomination for trustee of the Sanitary District of Chicago at the primary election Sept. 15. He is a son of the late Isham Randolph, formerly chief engineer to the Sanitary District, and from August, 1913, to date has been junior partner in the firm of Isham Randolph & Co., consulting engineers, Chicago, Ill., and Jacksonville, Fla., engaged in general engineering practice.

LeRoy K. Sherman, who has had charge of the construction and salvaging of government housing for industrial war workers, has resigned as president of the United States Housing Corporation, Washington, D. C., and has returned to Chicago. Mr. Sherman has become associated with the Edmund T. Perkins Engineering Co. as vice-president. Mr. Sherman is a civil engineer and graduate of Massachusetts Institute of Technology, is president of the American Association of Engineers and was formerly the engineer member of the Illinois State Rivers and Lakes Commission. The Edmund T. Perkins Engineering Co. will conduct a general practice as consulting engineers in municipal and sanitary work in addition to their specialty of land drainage and reclamation.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., SEPTEMBER 15, 1920. Number 11.

The Washington Public Service Commission Attacks Demagogues

Politicians of the demagogic type are promising voters that they will prevent street railway and other utility companies from securing rate increases. Although commodity prices and wages have doubled, the public is told that the utility companies have profited enormously in the past, that most of their stock is "water," and that consequently their rates of charge for service need not be raised. The public is ready to be persuaded that this is a fact, because its desire is first cousin to the statement that utility rates need not be raised.

The Washington (State) Public Service Commission has met the argument of demagogues and in one of its recent decisions (City of Wenatchee vs. Central Washington Gas Co.), has said:

> It is evident that this utility is staring bankruptcy in the face. The people of Wenatchee do not expect the Commission to pursue a course that will compel this plant to be junked and sold
>
> We cannot resist observing at this time that the people of that community, in all matters which have come before the Commission, have exhibited a most broad-minded, unselfish attitude toward their utility problems. Wenatchee appears to be happily free from that type of demagogue that seeks notoriety and position by picturing all public service companies as dragons seeking to devour the people whom he loves, and himself as the mailed knight, impatient to sally forth single-handed and pull the teeth of the monsters amid the blare of trumpets and plaudits of the multitude. Nor do we believe that the people of Wenatchee are of the type to be hoodwinked by that character of burlesque.
>
> In the hearings held there, which have always been well attended by the patrons of the utilities involved, we have observed a most wholesome attitude of honest inquiry and a manifest desire for justice to those who render service as well as fairness to themselves.
>
> The problems which come before us are at times exceedingly perplexing. In the early days of Commission regulation it was found that many public service companies were charging unreasonably high rates for inferior service, at the same time maintaining an attitude of arrogance toward the public. Sentiment was often bitter against such companies and not without cause. When the Commission began to function, high rates were reduced, service was improved, and the utilities induced to assume a more courteous bearing toward their patrons. The various Commissions availed themselves of that early opportunity for conspicuous and constructive service and naturally became popular
>
> In some instances earnings were scaled down rather too freely. The utilities continued operations on rates yielding a fair return under the comparatively low scale of wages and material prices which prevailed over a number of years. When war conditions came on and the prices of all materials and labor began climbing steadily, when many utilities saw disaster staring them in the face, they sought increased revenues through higher rates. We have held hearing after hearing where the cold undisputed facts compelled us to choose between higher rates or bankruptcy for the company rendering public service. In such cases we have permitted increases, not adequate in most instances, but sufficient in our opinion to tide the utility over what we hope will prove a temporary period of extremely high prices.
>
> The great majority of people affected have realized that the utilities' expenses, like their own, have expanded, compelling increased revenues. There are some, however who cheerfully pay $12 for a pair of shoes for which they formerly paid $5, 50 cts. for a beefsteak for which they formerly paid 20 cts., and who complain bitterly if the cost of a utility's commodity is increased 25 cts. per month, and accuse the Commission of favoritism toward the company if any increase whatever is allowed to meet growing wages and material prices. They seem to forget that the bulk of the expense in operating most utilities is labor, and that each member of the great army engaged in rendering public service is compelled to purchase the necessities of life at the same high cost that confronts us all. In fact, increases have been permitted by this Commission for the sole purpose of affording employes a living wage.
>
> We realize that it is not a popular thing to increase rates. It would be easy to deny such applications and pose dramatically as friends of the people, standing between them and corporate greed. We occupy a position of great responsibility. We have it in our power to bring ruin and disaster to many hundreds of utilities and rend the financial fabric of the State. It is very difficult now to secure capital for public service enterprise, and this Commission, by a rash stroke of the pen, could make it impossible in the state of Washington. We have endeavored in these trying times to save

legitimate investment in utility properties from ruin, preserve the necessary public service to the people, and, at the same time, be just and fair to the patrons who pay the price. If we should yield to the clamor of politicians, whose stock in trade is reckless denunciation of public utilities and abuse of the Commission for permitting them to live, the results would frighten even those irresponsible agitators.

We regard the foregoing quotation as an admirable example of the best method of meeting demagogic attacks on proposed or actual rate increases.

The Washington Commission points out that it is not popular to raise rates, and the public will not be slow to realize that since the Commission naturally desires general approval of its acts, it would not raise rates unless there was no doubt whatever both as to the economic necessity and the justice of doing so.

Must Workers Be Scourged to Their Tasks by Fear of Discharge?

It is exceedingly unfortunate that the average workman is so poorly educated in economic matters that he will loaf unless spurred to activity by fear of discharge or by hope of immediate increase in personal income. Let the argument be presented to him that the general level of wages in a country rises as per capita productivity increases, and he remains wholly indifferent. Perhaps it is true, perhaps it isn't, he says to himself, so why worry about it.

For several weeks past manufacturers have been reporting increases in the efficiency of employes. Fear of discharge seems to be the cause of this increase. We quote from an editorial article in The Iron Age entitled "Larger Outputs with Fewer Men":

> A manufacturing company employing hundreds of men recently let it be known that it would hire no more workmen, for the present at least. The psychological effect of this was apparent almost immediately in practical results. More and better work was done in that plant; there were fewer days off, less loafing on the job and greater production per man. Another company employing eighty men let thirty of them go. It was surprised to find that with the remaining fifty men it got an output equal to that which the eighty men had produced. A motor truck manufacturer, who cut down his working force about one-third, was surprised to find to what extent individual production increased, and he lost only two and a half trucks per day with his reduced organization.
>
> The cocksure attitude of workmen is not so common as it was a few months ago. In some branches of industry forces have been reduced, and while there is no great unemployment anywhere, men are becoming more jealous of their jobs. The workman, although he may not be in close touch with the "front office," knows that in some lines there have been many cancellations of orders, that production is being retarded by lack of raw materials and inability to ship out finished product, and that many companies are hampered in the conduct of their business by tight money and frozen credits. If he is a wise workman he will realize that today the manufacturer is not under the same compulsion to overlook slothful work as he was a few months ago when conditions were quite different.

It is really pitiful that many men must be thrown out of employment before the average workman will do a full day's work. As long as the average worker is ignorant of the economic law that, under competitive conditions, real wages (not merely money wages) increase with increased output per worker, just so long will fear of discharge bring an important discipline—unless ways can be found to make all employers apply piece-rate and bonus payments, profit-sharing and the like. Here again the ignorance of workers as to economic principles, coupled with their fears of the effects of cupidity on the part of employers, has led labor unions to oppose piece-rate and bonus systems of payment. Employers have a long, hard educational job (don't call it or regard it as a light) ahead of them, if they are to bring the majority of union workmen to a realization of the folly of their present attitude toward systems of payment in proportion to performance. Let this task be approached with determination and with complete co-operation on the part of employers, for upon its outcome depends, in large measure, the future economic progress of the American people.

A Common Fallacy in Rate Making

In an editorial article Aug. 21, the Electrical World takes a position relative to the valuation of public utilities that seems to us both legally and economically unsound. The World says:

> Attempts for rate-making purposes to value at present-day prices physical properties wholly or almost wholly constructed during the low-price periods before the war are likely to be the means of expending valuable energy that will not accomplish results and may produce bad feeling against utilities. The remedy for increased operating costs must to some extent be increased economies, though under existing conditions the chief remedy must be increased rates. Increased construction costs affect not only additions but also replacements of existing property that must be made through depreciation accounts.
>
> Increases in rates due to increased operating costs bear no relation to investment and must therefore be justified on operating facts alone. Fixed charges which are determined by investment in the business can be taken care of in two ways, one by arbitrarily increasing valuation figures to a point where certain fixed percentages will provide the necessary returns, the other by permitting investments to stand at whatever figures the records of construction costs justify and increasing fixed-charge percentages to meet conditions. Any rule must work both ways, and it must be assumed that if properties are valued at costs during high-price periods they must be similarly valued during low-cost periods. The second method has the advantage of justification on the basis of figures that are prevalent in the market and which cannot be a matter of opinion.

The fallacy in this argument arises mainly from confining the attention to the dollar paid to the investor as "fair return" without considering the purchasing power of that dollar. The wages of employes have been doubled solely on the ground that the purchasing power of the dollar has been cut in two. Then by what logic should the investor's income be restricted to payment in 50 ct. dollars? There is really no economic or ethical answer to this question, but there are many specious attempts to reply to it.

The editor of the World suggests increasing the percentage of "fair return" on the investment rather than increase the valuation of the property, but while this could be so done as to lead to precisely the same result, it would not be supportable in the U. S. Supreme Court. This court will protect an investor against confiscation of his property such as occurs when the annual return upon it falls below a low bond interest rate, say 5 or 6 per cent; but beyond that the court has never gone in providing protection. On the other hand the court has repeatedly held that it is not the "actual cost" but the "present value" that is in question when confiscation of property is being considered.

The editor of the World says that "any rule must work both ways," and suggests a loss of income if plant built at high prices is subsequently valued at low prices. But there would be no real loss to the investor in such a case, for although the number of the dollars annually earned on the then "present value" would be reduced, their purchasing power would rise exactly enough to offset the decrease in their number.

No thoroughly rational or fair treatment of this problem is possible until men cease looking at the number of dollars earned and direct their attention to the quantity of goods that the dollars will buy.

Publicity for Model Railroad Camps

The realization on the part of the railroads that better housing for its construction forces will mean an excellent investment by reason of reduced labor turnover, increased output of work and a better class of labor, has wrought very noticeable changes in conditions, as any "old-timer" can testify. Not only railroads, but lumber companies, contractors on construction work and various other organizations have seen the wisdom and economy of better housing facilities, especially within the last few years when the competition for such labor has been so keen.

It has remained for a labor supervisor on the Elgin, Joliet & Eastern Ry. to advertise and capitalize the merits of that company's camp at Gary, Ind., as noted in the Railway Maintenance Engineer. A group of neatly framed photographs was placed in the window of the railroad's labor office with a lettered notice drawing particular attention to the advantages of the camp. The pictures were selected with a view to illustrating those features of the camp in which the men would be most interested, namely, a neat kitchen, an inviting mess hall, a sanitary lavatory and a light and airy bunk house.

The Engineer and His Thinking

At the organizing conference of the Federated American Engineering Societies held in Washington last June one of the speakers referred to "the kind of thinking" of the engineer. Not once but many times, was the phrase reiterated, in varied form until it became the theme of the speaker in his argument for the recognition of the engineer, scientist and technologist as a potent but neglected force in public affairs. "It is the engineer's thinking for which he seeks recognition, as well as his works." The phrase is worthy of closer inspection and analysis. What is the engineer's kind of thinking? How does it differentiate him from his fellow citizens; from lawyers, financiers, business men, merchants, clerks, the men on the street? What leads him to do his kind of thinking? And what is, or would be, the value of bringing that kind of thinking to bear on public affairs?

A man's habit of thought is the product principally of his environment of his associations, training and experience. Out of them he acquires a characteristic viewpoint that determines his activities and modifies his opinions. From them he gets his ideas of efficiency, responsibility, fitness, integrity and reliability, all of which affect his usefulness as a citizen as well as his worth in his occupation. Measured by this yardstick let us see what kind of thinking we may expect from the engineer.

His training and education bring him early into contact with the inexorable laws of nature which are the foundation of his later work. With these he may not trifle and yet gain success. No amount of brilliant and clever argument will enable him to ignore the simplest laws of physics and mathematics. If he were not inherently honest he would soon become so or retire as a failure in his profession. Facts must be faced; materials of construction must be used for purposes for which they are best fitted; efficiency must characterize the performance of a machine; analysis must prevail instead of guesswork; tradition must be abandoned in favor of absolute knowledge; reason must prevail and law must be obeyed. The whole preparation of the engineer for his professional work makes him exact, precise, honest, efficient, unshackled by tradition, aggressive in attacking a problem, sound in analysis and judgment, and fearless in execution.

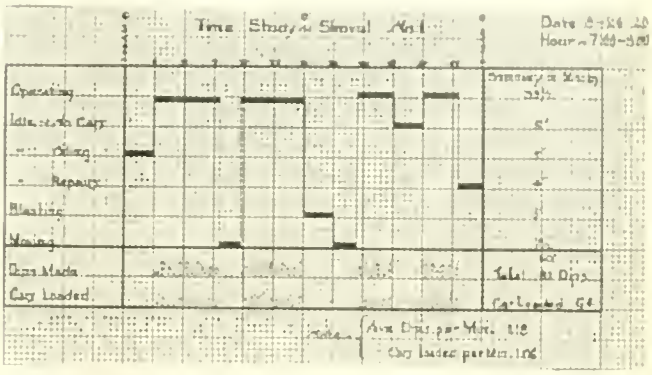
All of these are splendid traits and qualities for citizenship and government as well as engineering. In fact we are beginning to recognize government as a vast engineering undertaking, in which the fitness and integrity of men are fundamental necessities. By his training the engineer will bring a broader mind to bear on public problems than will the lawyer, financier or merchant. He will select men with much the same care and investigation that he selects materials. He will demand efficiency and good management, because those things are essential to successful business, and government is the great business of all. He will excel at organization and management, for these elements are primary in his scheme of things. And when it comes to great public works which are essentially engineering there is no argument as to the necessity for technical control and direction.

The engineer's kind of thinking fits him for almost any position in our scheme of government, unless it be in the judiciary; and even there we have increasing evidence of the need of technical advice. But certainly in the executive and legislative branches of government the engineer can find a widening field for his services. Officials, boards and commissions are in growing need of his advice and counsel. Civilization is becoming more complex, research and investigation are bringing to light things unknown to the non-technical citizen, and government is demanding wider and more comprehensive knowledge. Respect for law and order, which lies at the very basis of the engineer's training, is the imminent need of the world. These are the things for which the engineer's kind of thinking fits him, and to which he can bring a new and valuable force in his capacity as a citizen and government official.—Editorial in Chemical and Metallurgical Engineering.

Bids Asked for Shafts for Hudson River Tunnel.—Bids will be opened Sept. 23 for sinking two shafts for the vehicle tunnel under the Hudson River, to connect New York and New Jersey.

Graphic Time Study of Steam Shovel Operation

To the Editor: The article in your August 18 issue by D. J. Hauer on a time study of steam shovel operation interested me very much. I take no issue at all with the author, but I submit to you a graphic time study, using his figures on shovel operation for the first hour. With this form you need no instruments except your watch and pencil, and in the end of the study the summation of your hourly results is all that is necessary to find out how your machine is doing.



A record of this type can be readily referred to and easily understood, and is applicable to any time study.

A. L. SCHNEIDER.

Downingtown, Pa.

Wages of Assistant Engineers and Draftsmen in Railway Service

To the Editor: In the August 18th issue of Engineering and Contracting appears an editorial, entitled, "The Wage Increase of Railway Employes in General and of Engineers in Particular," from which I quote: "It will be noted that the average wage of the 10,000 assistant engineers and draftsment was $139 and has been increased to $170, etc."

On page 174 appears a table summarizing "Wages of Railway Employes," showing "increases awarded July 20th to employes of the railroads of the country by the Railway Labor Board."

Permit me to call your attention to the fact that the Railway Labor Board made no award whatever to assistant engineers and draftsmen, but on that date awarded increases to those groups of employes who were "properly before the board" seeking adjustment of wages and working conditions. The men employed in the engineering departments of the various railroads not appearing before the board were naturally not awarded one dollar of increase.

CONSTANT READER.

Chicago.

Economics in Engineering Education

To the Editor: In your issue of July 28 you recommend that engineering students be taught more of the theory of economics than they are ordinarily taught now. Although I do not pretend to know much about economics, I do not think that the ordinary course given to engineering students does them much good. Such courses are too dull and academic to instill in the students a curiosity about engineering economics. They are more likely to stifle what interest the student might later develop in the subject; much as the usual high school English course, by painful over-analysis of, say, Carlyle's essay on Burns, discourages the students from ever wanting to hear the name of Carlyle again.

Of course, it is possible to find a teacher possessing the proper combination of qualities to make a success of teaching economics, but he probably would not be engaged by the ordinary college dean, because of his differences from the pedantic type of instructors. And, once engaged, all the other professors of the faculty would insist in telling him how to teach economics. Somehow, a teacher of such a subject as economics or English on an engineering faculty is selected as fair game for every other professor to dictate to according to his hobbies. As Douglas Fairbanks (or some such famous movie star) says, the boy who shines his shoes tells him how to arrange his scenarios.

In the same issue of Engineering and Contracting you suggested that engineering students should be taught such matters as the invention of the slide-rule. I agree with you there. Such a course would be a history of science, and would furnish the student an outline of historical perspective, and a foundation upon which to choose wide reading in later years. A course in the history of science is much more valuable to engineering students than the intolerably dry study of "essays on style" that make up the usual course in engineering English. I tried the substitution at the University of Colorado, where Dean Milo S. Ketchum gave me a free hand, and incidentally became much interested myself in the history of science.

P. B. M'DONALD,
Assistant Professor of English,
College of Engineering, New York University.
New York.

Light Motor Truck for Street Railway Track Repairs

Mr. W. L. Whitlock, writing in the Electric Railway Journal, states that the Denver Tramway Co. has been using a 1-ton Ford Form-A-Truck for emergency track repairs and minor track maintenance work since 1916 and has found this a very useful addition to the way department equipment. This truck normally carries a crew of two men, but at present has in addition an apprentice track foreman.

This crew takes care of the majority of emergency track repairs and has in addition a regular order of work on minor track repair jobs. The emergency work comprises the usual jobs confronting any track department and consists of repairing broken rails, broken culverts, spread track, water on track, high paving, switches in bad order and items of similar nature. The minor track maintenance work is routine trackwork covered by authorized work orders or instruction sheets and includes replacing bad order rails, repairing joints, repairing special work, guard rail repairs, culvert replacements, cleaning track drains, cutting jobs by use of oxy-acetylene torch, replacing mate tops, small paving jobs and other items of regular track maintenance work.

Experience demonstrates that a 1½ or 2-ton truck should be purchased to replace this 1-ton truck in a very short time.

The following is a summary of the operation of this truck during December, 1919, and January, 1920:

TABLE SHOWING MONTHLY RECORDS OF MOTOR TRUCK.

	December, 1919.	January, 1920.
Performance data:		
Days worked	28	29
Locations worked on	96	105
Total hours worked	599	730
Average locations per day	3.42	3.75
Average hours per locations per day	6.23	6.95
Total number man-hours per day	21.39	25.17
Work done:		
Broken rails repaired	31	31
Spread track repaired	8	3
Special work repaired	27	28
Cutting torch jobs	24	18
Miscellaneous	15	35
Total	105	115
Operating data:		
Total cost operation, maintenance and depreciation	$170.53*	$ 72.01
Miles run	603.00	568.00
Cost per mile	$0.2828	$0.1268
Gallons of gasoline consumed	82	72
Miles per gallon	7.36	7.89
Average miles per day	21.53	19.58
Average milea per job	5.71	4.093

*Heavy repairs included in this item.

The cost of operation and maintenance for the years 1918 and 1919 was as follows:

TABLE SHOWING YEARLY DATA OF MOTOR TRUCK.

	1918.	1919.
Miles run	4,984	5,551
Cost per mile	$0.1422	$0.1856
Gallons gasoline consumed	829	697
Miles per gallon	6.01	7.9
Total cost per year	$708.85	$1,030.48

Relative Merits of Metal and Wood Ties

A comprehensive report on substitute crossties, submitted to the American Railroad Association by its Committee on Ties, has been made public recently by publication in Bulletin 227 of the association. An abstract of the report follows.

For many years efforts have been made to introduce substitute ties, the first ties being made of metal, then of concrete, and finally ties made of combinations of steel, wood and concrete. In Europe steel ties were introduced very early and a few types were rather extensively tried. However, relatively, the substitute tie has only had a limited use and where it has been used to more than a limited extent it has been under special conditions. For instance, the more extensive use in Germany was due to a desire to provide a market for the surplus product of the steel mills.

The wheel loads and traffic conditions on European roads are such that results obtained are no criterion as to what would be secured under American traffic and it is safe to conclude that, while much may be learned from European experience, no substitute tie has been developed there which would promise success in this country. The same may also be said as to the ties which have been and are now in use in Mexico, South America, Africa, Australia and India, in all of which countries the requirements fall short of those of roads in the United States and Canada.

The first trial of substitute ties in the United States, of which the committee has knowledge, was made in 1878. Since that time a large number of types have been tried, the majority of which have been tested only in small quantities. Many of these, especially in recent years, seem to have been designed by persons having slight knowledge of the fundamental requirements and were evidently put in track at the solicitation of the inventor rather than because of any serious purpose on the part of the railroad to develop a practical substitute.

The Steel I-Beam Tie.—The only substitute that has been manufactured on a commercial scale, and used extensively, is the steel tie, of "I" beam section, of the Carnegie Steel Co., approximately 1,250,000 having been put in steam railway track, of which approximately 1,200,000 have been used on roads affiliated with the United States Steel Corporation, notably on the Bessemer & Lake Erie R. R., which road has purchased 1,142,000 steel ties of this kind.

There are several designs, especially of the composite type; that is, of steel and concrete, and steel and wood, which promise to develop into successful substitutes, but their use has been so limited that definite conclusions cannot be drawn at this time.

The results obtained with the steel I-beam tie up to the present are covered in the following statements:

The steel I-beam tie has proved to be a practical substitute for the wood tie on non-insulated track under heavy and dense traffic.

Line, surface, and gage have been maintained on such track at reasonable expense.

No satisfactory method of insulating the I-beam tie has been developed.

Corrosion is a serious factor in limiting the life of the tie, and means of protection should be provided.

Because of the lack of definite information as to the average life of steel ties, sufficient data are not available to make satisfactory comparisons of annual cost as between steel ties and wooden ties.

Why a Substitute Tie Should Be Developed.—The committee is of the opinion that a substitute tie should be developed for the following reasons:

The probability is that the cost of wooden ties will continue to increase. Sufficient timber for ties is available at the present time and it is possible that, with the more extended use of preservatives, better means of protecting the tie from mechanical wear, and by reforestation, the railroads can obtain their requirements indefinitely. It is believed that it will simply be a question of price as to whether the timber available is converted into ties or whether substitute ties are used instead. As it is probable that a satisfactory substitute tie will be the result of progressive development, rather than instantaneous design, and that such development will require a considerable period of years, during which time the supply of timber will probably decrease, the railroads should take a more active part in the design and development of substitute ties.

Efforts to lower the cost of maintaining track by reducing the amount of labor required.

Conclusions of Committee.—No substitute tie has as yet been developed which can be recommended for general use on high speed insulated track.

The development of substitute ties should be taken up by the railroads with a view of conserving the available timber supply—of producing a track structure of longer life—which may be maintained with less labor.

Any statements made to urge the introduction of a substitute tie on the claim that safe track cannot be maintained with wooden ties, such as will be available for some time to come, are without foundation and are contrary to the facts.

History of Substitute Ties.—It is probably not generally known, even among railroad engineers, that attempts to produce satisfactory ties of metal date back over 60 years. A great many forms of substitute ties have been brought out, not only in foreign countries where suitable tie timber has been less plentiful, but also in the United States.

The fact that no substitute tie has yet been developed which can compete, under ordinary conditions, on the total annual cost basis, with wooden ties has tended to make the whole subject of little more than academic interest to railroad managers. Also the limitations under which railroad managements have been put, by reason of insufficient income, have made it largely impossible to consider such problems as the possible future failure of the timber supply and means to defer or overcome it. With a few notable exceptions, the railroad engineering departments in recent years have had to be content with seeing that each test was made under the most severe conditions as to traffic, and, with certain exceptions, there is little evidence of effort to develop a rational substitute tie.

This attitude is no doubt partly due to the fact that a number of substitute ties have been handled by promoters in such a way as to at least give good reason for the idea that the companies backing them are more interested in selling stock than ties. It has been the experience that a number of substitute ties while under trial for the first 6 or 8 years have given great promise of meeting the requirements, and have been very highly spoken of by those interested in them, only to fail and require complete removal from the track in less than 10 or 12 years, or in less than the average life of properly treated wooden ties.

Future Supply of Tie Timber.—The standing timber in the United States totals 3,000 billion board feet. It is being cut at the rate of 100 billion board feet per year. It is growing at the rate of 35 billion board feet per year. It is being destroyed by fire, insects, decay and waste at the rate of 35 billion board feet per year. Thus the growth and the destruction counterbalance each other. Therefore, 30 years is the extent of the supply, if the assumption is maintained that consumption will continue at the rate of 100 billion and destruction at the rate of 35 billion. The decline in the consumption of sawed lumber from 45 to 35 billion during the past 15 years is a permanent tendency marking the usual industrial development from free, wasteful use of a plentiful, cheap commodity to a conservative utilization as that commodity increases in value through being less available. Consequently, less than 100 billion board feet will be used in the future. The unaided natural growth of 35 billion board feet will be increased because forest products will become worth the cost of growing them. The destruction by fire will be reduced from the present 10 billion board feet because the consequent financial loss will not be tolerated. These factors will make the present supply and the new growth last at least 50 years.

Cross-Tie Supply and Consumption.—Cross-ties constitute less than 5 billion board feet per year of the United States forest consumption. They can be made from every kind of tree represented in the estimates of standing timber. Consequently, wood for cross-ties will be available as long as it can be purchased. Since woods of certain kinds and sizes will not be available in satisfactory quantities and qualities for certain other purposes before they cease to be available for cross-ties, it is a safe assumption that wooden cross ties can be had for well over 50 years.

The general figures for the United States do not, of course, represent conditions everywhere in the country. Nearly one-half of the timber is in the Pacific Northwest. About one-quarter is in the South Atlantic and Gulf States, so locally, the cross-tie supply situation of a railroad may be unsatisfactory. A railroad cannot move to the source of its wood supply, as may be done by a manufactory. Consequently some railroads which began operations in a forested territory have had to go as far for some of their ties as railroads which operate through the prairie areas. This has resulted in ties grown in Florida being used in Maine and ties from Texas going to California. Under the special stress of war conditions ties from Washington and Oregon have been shipped by rail and water to New York and Pennsylvania.

Railroads have gone long distances for ties because they considered their local supplies insufficient. Seldom have they pushed local production to the utmost. Through preferences for particular woods they have ignored other possible kinds.

An example of what can be done in developing local production is given in the Eastern Region (U.S.R.A.) figures for 1918 and 1919, when 3,798,350 ties were increased to 8,485,800, or 150 per cent on a group of 45 railroads which had previously assumed that their limit had been reached.

Woods which are in special demand are the first to become scarce, as, for example, white pine and black walnut. At present white oak is so much in demand that the supply is diminishing at a rate which promises a decided shortage of such ties within a short time. It is because some railroads persist in preferring certain woods that are becoming scarce to the exclusion of others that color is lent to the tale that cross-ties are not to be had.

If only woods which wear best or last longest or which combine these qualities were used as cross-ties, the supply would not be sufficient for the demands of even the immediate future and substitute materials would be a pressing need.

A full utilization of the available supply of timber will provide sufficient cross-ties for at least 50 years, since none of the kinds of wood included in the estimate of supply are unsuited for use as cross-ties.

Conservation of Ties.—Fortunately, wood has been chemically treated so as to enable it to last longer than it has been possible to protect it from mechanical destruction, which is now the limiting feature of treated tie life. The protection against mechanical wear has contributed considerably to the average life of untreated ties. The further development of this protection will add additional life to treated ties. This makes of every piece of woodland in the country a potential source of tie supply, which fact means a practically universal distribution of this essential part of railroad track structure.

The untreated ties put in the tracks of United States railroads average about 7 or 8 years in service. Under methods of treatment and protection now in use, these ties will give about 15 years' service. If the 100 million untreated ties used per year were thus conserved, the lessened consumption of 2 billion board feet of timber annually would contribute appreciably to reducing the drain on the forest resources of this country.

It is evident that instead of concerning themselves over the supply of ties, the railroads through wise handling should conserve those they use.

Some Fundamentals Regarding Substitute Tie Design.—The Tie Committee in its investigation of various substitute ties has been impressed with the fact that many of them violate fundamental principles of track construction or maintenance. The experience with substitute ties, so far recorded, indicates the following features as being productive of failure:

(1) Lack of efficient protection against corrosion.

(2) Failure of rail fastenings.

(3) Failure of insulation.

(4) Loss of beam strength due to weakening tie in vicinity of rail to accommodate rail fastening features.

(5) Use of sharp interior angles or square holes, from which cracks are developed.

(6) Lack of protection against derailed wheels.

(7) Design of base of tie such as to render tamping difficult or impossible and such as to make maintenance of proper surface of track impracticable.

(8) Design of tie such that track will not hold line, or such as to make lining of track impracticable.

(9) Lack of beam strength causing breakage on yielding roadbed.

(10) Lack of protection from abrasion from ballast in concrete ties.

It is believed that any track supported on ties will not remain permanently to gage, surface and line and that the labor operations necessary to restore it to gage, surface and line will have to be performed with more or less frequency. Therefore, any substitute tie should be designed as far as practicable to

(a) Resist the forces tending to disturb gage, surface and line, and

(b) Lend itself readily to the labor operations necessary to restore the track to its original position.

It is recognized that no tie can completely meet these requirements and that the most that can be expected is a compromise.

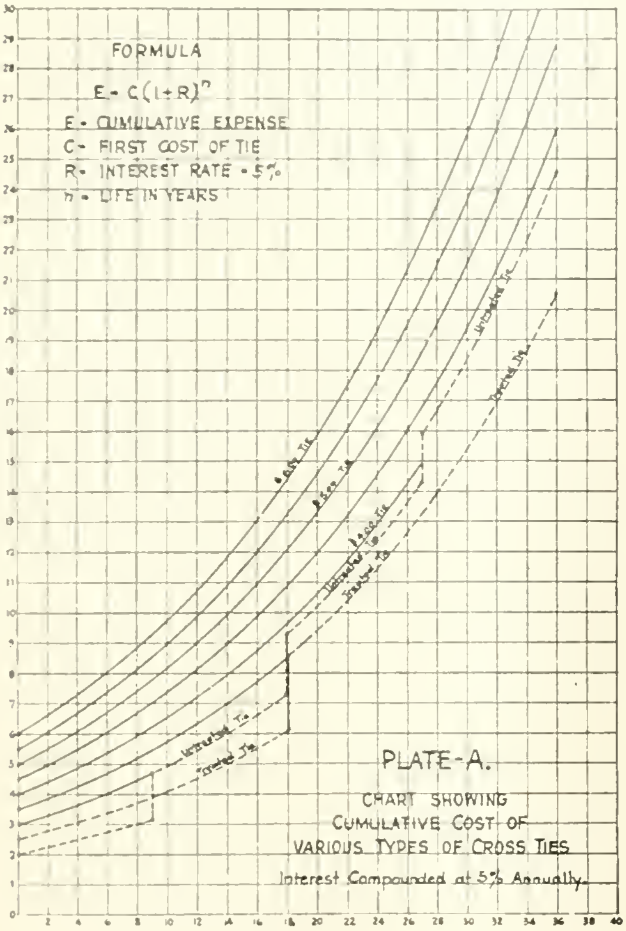


Plate A.

The fastenings, in addition to being of sufficient strength to resist the stresses produced by traffic, should be of such design that without taking the tie from the track and without change to the holes or fixed bolts or projections in the tie, a reasonable change of width or base of rail or variation of gage may be made. The fastenings should provide a freeway between the base of rail and lip of the fastening.

If the tie is so designed that it is essentially one support under each rail united by a transverse member to hold gage, this transverse piece must be of sufficient strength to maintain gage under all conditions.

The tie should have sufficient strength as a beam to support the loads imposed without undue deflection, so that the load may be distributed properly over the tamped bed.

The shape of the base of the tie must be such that it will not cut into or destroy the tamped bed. And further, it must be possible to readily tamp the ballast under the tie.

The tie should be of such shape that it will not only resist the tendency of track to get out of line, but also permit the track to be thrown back to line.

Ties clamped in pairs or which enclose considerable amounts of ballast between their several parts to such extent that the ballast must be removed before the track is lined, would add a material burden to the labor necessary to line track.

Projections on the base of the tie that project into the ballast would make necessary throwing the track out of surface before same can be lined. Such a design would so interfere with lining track as to make it impossible.

The end of the tie should be of such shape that the ballast beyond the end would offer resistance to the lateral movement of the track.

In addition to the above the following features should be provided for:

(c) Insulation or the possibility of insulation without a material change in the tie proper should be provided.

(d) The fastenings should be such as to offer as little obstruction to derailed wheels as possible. They should permit the changing of a defective rail or the renewal of rails with ease, and should be of such character that they can be replaced if broken or defective without disturbing the tie.

(e) The tie should be of such design as to be able to stand a reasonable amount of punishment from derailed cars.

Relative Costs of Substitute Ties and Wooden Ties.—The subject of relative costs between wood and substitute ties must of necessity be limited to the application of known costs for comparison.

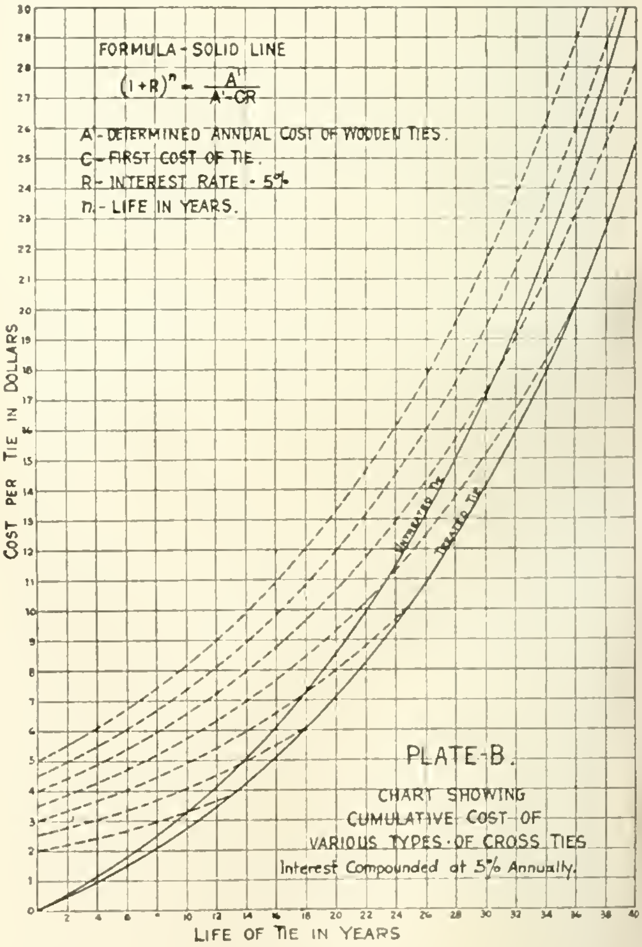


Plate B.

A preliminary survey of available data at once indicates that there is very little information as to the present day cost of substitute ties.

Therefore, it has been necessary, in preparing diagrams, to first establish cost curves of wood ties over a period of years, assuming a certain average life for untreated ties and another for treated ties. The various items of cost entering into these curves are merely assumed for the purpose of illustration.

It is conceded that these costs vary in different parts of the country due to varying factors, for example kind of wood, length of haul, etc. The costs used are thought to be nearly the average.

Inasmuch as known costs of substitute ties are unavailable, a comparison has been made by using a unit cost in place as compared to wood ties in place.

No effort has been made to show the comparative effect of the cost of maintaining track where substitute ties are used as against wood ties under similar conditions.

Plate A shows actual expenditures for any given period, the untreated tie, with life of 9 years, the treated tie, with life of 18 years, and substitute ties ranging in first cost from $3 to $6, by 25c intervals, with indefinite life, the curves being carried out to 36 years. The chart is made up on a basis of 5 per cent interest compounded annually.

In Plate B the curves for substitute ties are the same as Plate "A," and are shown in dotted lines. Curves for treated and untreated wood ties (solid lines) show annuity value rather than actual expenditure at any given period. These curves are calculated from expenditures at renewal periods, as determined on Plate "A."

Plate "A" merely reflects the basic information by which the curves on Plate "B" for treated and untreated wood ties have been determined. Plate "B" will thus show that a substitute tie, having a certain unit cost in place, must last a certain number of years to become as economical as a good tie, for example—a substitute tie costing $3.50 in place must last at least 23 years and 4 months to be as economical as an untreated wood tie costing $2 in place with 9 years' life and must last 25 years to compare with a treated tie costing $2.50 in place and having 18 years' life.

The cost of treated and untreated wood ties in place in these diagrams is based on the following assumed data:

UNTREATED TIE.

Item	First insertion	Second insertion
Untreated tie	$0.75	$0.75
2 tie plates	.45	
4 spikes	.05	.05
Labor	.40	.40
	$1.65	$1.20
Transportation	.35	.35
Total	$2.00	$1.55

TREATED TIE.

Item	First insertion
Treated tie	$1.25
2 tie plates	.45
4 spikes	.05
Labor	.40
	$2.15
Transportation	.35
Total	$2.50

The transportation costs given above are based on an average haul of 700 miles at 5 mills per ton mile.

I. C. C. Railway Valuations. In considering the recent rate case the Interstate Commerce Commission obtained a summary of the work of its valuation commission. This summary prepared by the commission's own engineers indicates that for fifty railroad systems with an aggregate mileage of 51,853 miles the cost of reproduction new, based on 1914 figures, would be $3,203,782,543, while the book value of these according to the property accounts of the companies, aggregates $3,158,275,156. Reproduction costs exceed book value by 1 per cent, and outstanding securities are something less than the book values. Of the total reproduction costs as calculated 91 per cent represented construction and only 10 per cent land.

For the ten largest roads in the list of fifty covered by the report the comparison between the railroad property accounts and the engineer's reports was as follows:

	Railroad property investment account	Government's report of cost of reproduction including cost of land
Great Northern	$384,27[illegible]	$418,201,325
Chicago, Rock Island & Pacific	341,4[illegible]	388,691,208
New York, New Haven & Hartford	1[illegible]	219,799,123
Boston & Maine	195,9[illegible]	276,528,128
C., C., C. & St. Louis	144,377,[illegible]	179,260,845
Oregon-Washington R. R. & Nav.	156,64[illegible]	113,147,128
Minn., St. Paul & Sault Ste. Marie	116,[illegible]	111,701,111
Oregon Short Line	113,09[illegible]	104,685,219
Chicago & Eastern Illinois	78,[illegible]	77,751,865
Central of Georgia	62,60[illegible]	73,609,448

Railroad Grade Crossing Elimination*

SAMUEL T. WAGNER

[illegible]

Let us assume that a railroad is constructed through a community which is more or less sparsely settled. After its completion the improvement of the surrounding country with its villages and towns call for development along the line. Additional highways, as the necessary arteries of traffic are constructed to care for changed conditions and in many cases are forced to cross the line of the railroad at the same level as the tracks, making what is technically known as a "grade crossing." Many of this type of crossings were probably formed when the railroad was located by its crossing the then existing highways. We have thus in either case the creation of a condition which is bad and which becomes worse as the traffic on either the railroad or the highway, or both, increases. Not only is it a dangerous condition, but, occurring when traffic is heavy on both railroad and highway, may become extremely objectionable on account of delays to traffic on the highway.

The present discussion does not cover those conditions which occur when one railroad crosses another at grade. This type of crossing, while dangerous, is more readily taken care of by carefully-designed electrical and mechanical apparatus known as interlocking signals, and the danger is reduced to a minimum.

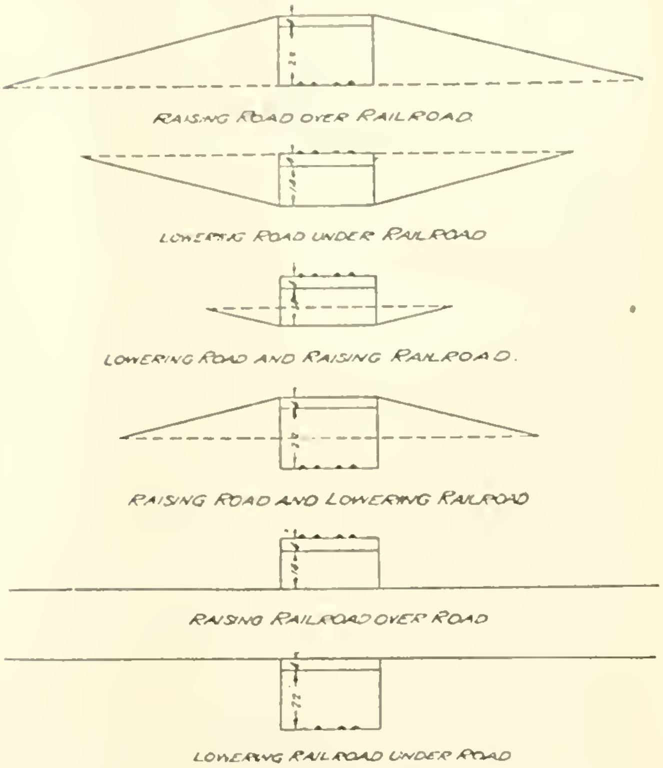

RAISING ROAD OVER RAILROAD
LOWERING ROAD UNDER RAILROAD
LOWERING ROAD AND RAISING RAILROAD.
RAISING ROAD AND LOWERING RAILROAD
RAISING RAILROAD OVER ROAD
LOWERING RAILROAD UNDER ROAD

Fig. 1—Sketch Showing Methods of Eliminating Grade Crossings.

When railroads were constructed many years ago they crossed most of the existing highways at grade. Any other method in those days would have been impracticable on account of the cost of building under or over them, and in many cases, if the crossing had been required to have been eliminated at that time would have resulted in the abandonment of the construction of the railroad on account of the difficulty of obtaining the necessary funds. In many cases also where new highways were opened over the railroad at grade their construction in any other manner would have been prohibitive for the same reason.

At the present time the situation is changed over practically the entire country; no new railroad or highway can cross the other at grade. Existing laws provide against such construction in most places. Such laws are proper and advisable in every way.

Our problem is, "How are we to get rid of the old 'grade crossings' that are in existence? What are the methods by which we can accomplish the desired end in the best manner?"

---

*From a J. A. Aldred lecture at Johns Hopkins University.

The Problem in Detail.—The engineering problems required in such construction call for a high grade of engineering skill, and cover among others the following specialties of the art of engineering:

Construction and location of railroads and highways.

Railroad and highway bridges.

Sewerage and drainage problems.

Construction of retaining walls, etc.

In involved problems, the reconstruction of railroad yards, passenger and freight stations, locomotive and car facilities, which may be affected by the changed conditions.

Changes in the industrial connections with the railroad.

Electrical and mechanical engineering problems. Lighting, duct work, power houses, etc.

In a general way there are six methods by which a "grade crossing" may be eliminated:

1. Raising the highway over the railroad.
2. Lowering the highway under the railroad.
3. Lowering the highway and raising the railroad.
4. Raising the highway and lowering the railroad.
5. Raising the railroad over the highway.
6. Lowering the railroad under the highway.

These methods are shown in a diagrammatic manner in Fig. 1.

Which of these is to be used depends entirely upon the local conditions in each case. The relative importance of the railroad and highway, together with the question of cost, are the usual deciding factors. The latter is of great importance, as neither the railroad nor the community derives any financial benefit from the expenditure.

The problem is further complicated when a number of crossings are located so close together that they must all be treated at the same time. Nothing but the most careful engineering studies and estimates of cost will determine which is the best for any particular case.

Experience shows that the greatest costs will be indicated when the highways are to be carried over the railroad. In this case a clearance of at least 22 ft. is required over the railroad tracks, plus a depth of about 4 ft. for the bridge, making a total of about 26 ft. for the change. If the railroad crosses the highway a clearance of 14 ft. over the highway, plus a depth of about 4 ft. for the floor of the bridge, makes a total of about 16 ft. The difference of 8 ft. between these two cases represents a large expenditure of money.

When the territory adjoining the railroad is built up with expensive properties the damage to the properties caused by any change in the elevations of the highway may be great and must be considered as part of the cost of the scheme. Sometimes also the change in the level of the railroad may be very serious where it involves the reconstruction of railroad yards, stations and other facilities.

Again the depression of either railroad or highway may involve troublesome and expensive problems by the creation of a hole which it may be difficult to drain. This is specially true in level country.

Frequently in built-up territory, as in a city, the depression of the tracks of the railroad may offer the most aesthetic solution of the problem from the standpoint of the city, as it allows the elevation of the streets to remain unchanged. An elevated structure never presents a very pleasing effect.

As between a complete elevation of the railroad and a complete depression of the same, we have facing us the question of cost. In two large problems in the same city involving very similar conditions the relative expenditures expressed in costs per mile of the railroad were as follows:

Depression of the railroad	$2,700,000
Elevation of the railroad	1,891,900

Legislation.—A whole volume might be written on the question of existing State legislation regarding the question of "grade crossing elimination." It must serve our purpose for the present discussion to say that existing legislation provides about as many varieties of the division of the costs of grade-crossing elimination as there are varieties in engineering solution. In some states the laws require practically the entire cost to be borne by the railroad; none of them place the whole cost on the community. Between these two we have a great variety in practice as to how the cost of the work is to be divided between the railroad, the state, the county and the township. In quite a number of instances the practice is divided about equally between the railroad and the community, the percentages varying in the state, county and township. Most of these latter cases are where the blame—if it can be so called—for the original creation of the crossing is fairly divided between the railroad and the community.

Financing Grade Crossing Separation.—A railroad cannot go out into the market and borrow money for a project which will not show a return on the investment; therefore, it is usually compelled to provide the money for such improvements from funds derived from operating returns. Much as the railroads would like to proceed diligently in the prosecution of such work, they are forced to go slowly on account of the difficulty of obtaining the necessary funds. Municipalities are able to borrow on bonds for such purposes, but it must be borne in mind that the cost thereof is spread over the entire territory covered by the taxable power which borrows the money.

For the above reasons it is advisable that all existing grade crossings should be classified in order of their importance, which is generally based on the combined traffic on both railroad and highway, although peculiar dangerous local conditions may have much weight. For instance, we might divide them into three classes and number them "A," "B," "C." If this were done it would be good policy not to proceed with the elimination of any crossing in Class "B" until all in Class "A" had received attention. This would prevent any comparatively unimportant crossing being taken up out of place.

Maintenance of Travel During Construction.—It is quite evident that one of the serious problems arising in the practical application of work of this kind is the manner in which (a) the traffic on the railroad is maintained during construction, (b) the traffic on the highway is kept open.

As in the general problem, this detail is one that depends entirely upon local conditions, and has to be solved for each special case. Whatever method is decided upon is sure to result in some inconvenience to both railroad and highway traffic during construction. It may mean handling traffic on half of a highway or on a single track of a double-track railroad. Sometimes it is possible to detour both kinds of traffic, but this is rare. Generally it is very difficult to change the grade of a highway and maintain traffic. It is only in rare cases where traffic is maintained on half of a highway. Restricted traffic on a railroad is usually easier to care for in a physical manner, but the delays to traffic are serious. In case the highway is a city street, the work involved is very complicated, as it involves the care and moving of all underground structures, as conduits, sewers, water and gas pipes and their house connections, so that the whole bed of the street is practically torn to pieces. While all this is being done it is very difficult to maintain travel.

Some method has, however, to be found in each case to take care of both kinds of traffic during construction, and the simplest and cheapest is always the best.

Aesthetic Considerations.—Particularly in cities and in suburban sections the question of a pleasing looking structure is of importance. There is probably no type of engineering work which is harder to treat aesthetically than the structures required in the elimination of grade crossings. This means that the engineer should do his best consistent with economy.

If there happens to be sufficient headroom, no form of structure is more pleasing to the eye than an arch, and it should be used not only for its pleasing appearance, but also for its low cost of maintenance. Generally, however, some type of girder construction becomes necessary in order to utilize every inch of headroom. When this is the case it is advisable to place as many supports in the highway as is possible so as to reduce the length of the span and the consequently greater depth of the girders. This is also of prime importance from the safety standpoint of the railroad, as it prevents girders projecting above the tops of the rails, forming dangerous obstructions to the trainmen.

Columns on the curb lines and in the center of the driveways will generally accomplish this, and the objections held at one time to the division of a driveway by a line of columns are fast disappearing, as such construction serves to separate vehicle traffic and keep it on the proper side of the highway. The lower the depth of the girders over a highway the more pleasing looking is the structure.

Sluicing Methods for Core of Hydraulic Fill Dam at Huffman, O.

In constructing the hydraulic fill dams of the Miami Conservancy District the rule adopted as a safe mean is to make the core thickness at any point in the dam equal to the distance from that point to the dam crest. This makes the core at the base not more than one-fifth of the dam thickness. The borrow pits, from which the materials are obtained to build the dams, ought to contain a ratio of fine materials forming the core, to sand and gravel, forming the shoulders, to fit the above ratio. Otherwise an excess, either of fine or coarse, must be thrown away after being excavated, involving an addition to the expense of the work. If a borrow pit lacks either fine or coarse, the lack must if possible be supplied by opening another pit containing a proper proportion to correct the difficulty.

At the Conservancy dams, preliminary explorations were made, by means of borings and test pits, to determine the grading of the materials, and best locations for the borrow pits to be opened. In most instances a favorable grading was obtainable. At Huffman, however, the preliminary explorations showed that on the valley bottom just above the damsite, the most economical location from other considerations, there might be a lack of "fines," and the grading of the material deposited in the dam, when this borrow pit was opened and construction was begun, bore out the probability. The gravel retaining embankments rose at a normal rate, but the core did not. The core pool, kept at normal width, deposited so little silt along its sides, which are formed by the sand and gravel retaining embankments, that it was unable to keep itself water-tight. The water seeped away through the embankments at the rate of about 6,000 gal. per minute, requiring almost the entire capacity of a 15-in. dredge pump simply to counteract the leakage and keep the pool level at the proper point. This was of course a certain symptom indicating the lack of sufficient fine material in the borrow pit to build up a proper width of core. How this difficulty was overcome is told in the August Miami Conservancy Bulletin from which the matter in this article is taken.

Several methods of remedying the difficulty were proposed. One was to dig to a less depth in the borrow pit. The upper layer of the valley floor material, only a few feet thick, contains a much larger percentage of clay than the layers below. By adjusting the depth of digging, the material could be given the required proportions. But this shallower digging would require to be extended over a wider area to obtain the same amount of material, and this would require more construction track building, and would also increase the average distance the material must be hauled. Both items would increase the cost.

An alternative plan considered was to set a steam shovel to excavating in a clay bed along the edge of the valley, at the foot of the hills, and mix this clay in the hog box in proper proportions with the materials from the valley bottom pit. This would have required the purchase of additional large equipment, thus again increasing cost.

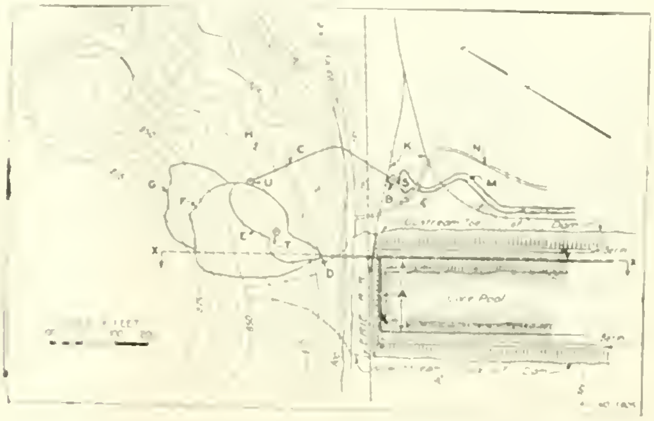
The third proposal was to "sluice" the aditional fine material, necessary to a proper "mix," down from the hillside at one end or the other of the dam. At the south end the preliminary borings and test pits had showed but a few feet, and sometimes but a few inches, of the necessary fine clay and earth. At the north end, however, the tests showed a top layer of from 2 to 8 ft. of yellow clay, with some sand and gravel; and below this a layer of from 4 to 12 ft. of hard blue clay; making from 6 to 16 ft. of the fine materials desired.

The general scheme as proposed was to wash down this material with a powerful water jet, or "monitor," and run it down the hillside by gravity in a ditch or "ground sluice" into a cistern or "sump" at the foot of the slope, when it could be pumped by a dredge pump up to the dam embankment. The only additional equipment necessary in this case would be the monitor and a pair of high pressure centrifugal pumps, with the electric motors to drive them. Much of the material would be quite tough to tear down with a monitor, but even so, the cost would be probably less than the excavation of the material in the main borrow pit (by dragline excavator), and would certainly be no greater. The monitor pumps would be placed at the [illegible] and fed by a ditch connecting with Mad River.

Further study of the topography showed that it was possible to improve this scheme by carrying the mixed earth and water from the upper part of the hillside borrow pit directly to the top of the dam embankment by gravity by means of a "flume," thus saving the cost of pumping this portion of the material, about half the total available, from the sump at the valley bottom to the top of the dam. This modification was therefore adopted.

Such a method of carrying the "hydraulicked" material from the borrow pit to the dam top was in fact the original one used in the development of this process of dam construction in the early days of California placer mining. The flume was usually an open topped square box or trough of plank, laid on top of a trestle, the latter being built on a slope of from 3 to 6 ft. in a hundred, and leading from a ditch or "ground sluice" in the borrow pit, up on the hill side, to the top of the dam embankment in the valley below. The slope of the flume is kept as uniform as possible, and sufficiently steep to give the water a velocity which will roll the coarsest material (which might be stones weighing hundreds of pounds), down the flume to the dam embankment. The finer the material to be carried, the flatter can be the slope, slower water velocities being sufficient for these finer materials.

Evidently also, the flatter the slope, the farther the material will be carried, with a given drop from the borrow pit to the dam. This last principle was applied at Huffman, as will be seen.



Layout of Hillside Borrow Pit at Huffman Dam.

"A" is pipe flume line; "B," high pressure pump house; "C," high pressure pipe line; "D," entrance to pipe flume; "E," upper limit of borrow pit, May 1; "F," upper limit of borrow pit, June 1; "G," upper limit of borrow pit, July 1; "H," $3\frac{1}{2}$ per cent grade line up the hill and limit of the borrow pit; "K," construction tracks, "M," supply ditch connecting with Mad River; "N," road, "S," sump; "T," first location of monitor, "U," second location of monitor.

There being plenty of 15-in. steel dredge pipe on hand at Huffman, this was substituted for the wooden box flume, with several advantages. One is a less frictional resistance to flow than with a box flume of the same section. A more important one is that no trestle need be built to support it, since it can be laid following the inequalities of the ground, the head of water in the pipe on the hilltop driving the water through the level pipe below. At Huffman a short trestle was in fact built, but it was only to carry the pipe line over the Erie Ry. line, high enough to clear traffic, the track running along the foot of the hill between the borrow pit and the dam embankment.

The pipe flume has the additional advantage at Huffman, as compared with an open box flume, in the flexibility with which it can be adapted to carry both coarse and fine materials to maximum distances. The Huffman hillside borrow pit contains considerable coarse material. To give the water sufficient velocity to carry this, the trestle across the Erie tracks has to be given a $3\frac{1}{2}$ per cent grade, and the distance out on the dam to which the material can be carried is of course marked by the point where this $3\frac{1}{2}$ per cent grade strikes the dam top. With an open box flume, this would be the limit to which any material could be carried, coarse or fine, without building a second flume. With the pipe flume, however, a thousand feet of pipe has been run out along the level damp top from the foot of the trestle, carrying the fine materials this additional distance, under the driving power given by the head of water in the pipe on the trestle slope. With coarse materials this head is all used up just to keep the material moving down the 3½ per cent grade, leaving no head available for further work. The maximum gradient used with the finer materials has been as low as 1¾ per cent these materials being about 80 per cent clay and the rest sand and gravel. The coarser materials contain about 75 per cent sand and gravel (up to stones about 12 in. in diameter), the remainder being clay. To carry the fine materials as far as they are carried by the pipe flume, a second box flume and trestle would have been required, built from end to end on a 1¾ per cent grade. Such a flume, if built, would not carry the coarse materials, but if fed with them would jam up and choke. On the other hand, the same pipe flume carries both coarse and fine, being extended length by length for the fine, down the length of the beach slope, just as in the usual operation for hydraulic fill. At Huffman, with fine materials occurring in one part of the borrow pit, and coarse in another, this flexibility of the pipe flume system has a great advantage.

Mention has been made of the tough blue clay of which much of the borrow pit is composed. It was known that this clay, inter-laminated with shale in places, would be hard to break down with a hydraulic monitor, especially if the jet were small or if its velocity were low.

New Hydraulic Monitor at Work at Hillside Borrow Pit.

It is usual to bring water to the borrow pit in considerable quantity at low head, to assist the water from the monitor in washing the material down the ground sluice after it is broken by the jet. At Huffman, to increase the power of the monitor, it was decided to make the size and velocity of the jet sufficient to yield all the water necessary to sluice the material after excavation.

The monitor has a length over all of 15 ft., and it can shoot a jet 5 in. in diameter with a "muzzle velocity" of about 140 ft. per second, delivering 3,800 gal. of water per second, the pressure within the nozzle being about 135 lb. per square inch. The water is supplied by two 10-in. centrifugal pumps, each driven by a 200 h.p. motor. The two pumps are connected "in series," or "tandem," so that the outlet of one discharges directly into the suction pipe of the second. With this powerful equipment it has been possible, in spite of the hardness of the clay and shale strata, to break the material down without blasting.

A notable feature of the slucing layout described is the small force of men necessary to run it. One pumpman, one monitor man, one man at the pipe flume inlet to keep it clear, and two men at the discharge end on the dam, constitute the gang; five in all. At intervals, when it is necessary to move the giant to a new location, some additional help is required. Another feature is the simplicity of the layout, and the consequent freedom from liability to shutdown for repairs. The efficiency of the plant is proved by the records of runs day after day without such delays.

The new plant began operating about the first of May, and the results of the first three months' work have been very satisfactory. The seepage from the core pool has been stopped, as was proved when a 42-hour shutdown over the Fourth of July vacation lowered the pool level only about two inches, whereas before the installation of the new layout a 13-hour shutdown would lower it 1.9 ft. The increased fine material sluiced into the core has built it up to its normal height, where it is being kept at proper elevation in relation to the sand and gravel beaches.

Another satisfactory result has been the reduction in cost. In spite of the toughness of the borrow pit material referred to, the cost of excavating and sluicing it to the dam has been only about 48 per cent of the cost of placing materials in the dam by the other methods in use. This result would alone have justified the cost of installing the layout, and if the hillside contained sufficient material it would pay to enlarge the equipment, and use it for building the entire dam. The lack of sufficient hillside material, however, compels the continued recourse to the valley bottom borrow pit as heretofore.

The capacity of the new layout is sufficient to sluice all the available hillside material into the dam before it is completed, using at the same time the valley bottom borrow pit material as originally planned.

The work at Huffman is in charge of C. C. Chambers, division engineer, J. S. Gena, office engineer, and Verne Clawson, superintendent of construction. The hydraulic fill work at all the dams is under the special superintendence of George L. Albert, hydraulic engineer for the district.

Copper in Steel Tie Plates Reduces Corrosion

The New York Central Ry. has conducted a series of tests under the direction of J. V. Neubert, engineer maintenance of way, Eastern Lines, to determine the relative loss of metal in tie plates of various compositions, including those containing a small percentage of copper. The length of time over which the tests were conducted varied from 2 years to a maximum of 6 years, and some of the tests are still in progress. The results are summarized in a recent issue of the Railway Age.

In all cases the maximum corrosion developed on the bottom or under side of the plates, a result contrary to the generally accepted theory of most engineers and maintenance of way men that the maximum corrosion takes place on the top or exposed portion.

The percentage of copper in the plates containing that metal ranged between 0.25 per cent as a minimum and 0.5 per cent as a maximum, the plates so treated being rolled otherwise according to the standards of the New York Central Ry. The copper-treated plates so obtained were subjected to the same tests as the other plates. An exposed test on a number of steel tie plates rolled from mild Bessemer steel containing 0.25 per cent copper and a number rolled according to the same specifications without the copper content showed an average loss of 8.88 per cent for untreated plates and only 1.46 per cent for the treated plates.

A second exposed test was made which covered a larger number of tie plates rolled from metals of various compositions. The plates used in this instance were cleaned and then exposed on the roof of a building at Hoboken, N. J., where the action of the salt air of New York bay could be studied. Investigation showed that the loss on the copper plates varied from 0.46 to 0.72 per cent, with an average of 0.56 per cent.

In comparing the data so obtained the nearest approach to the results reported from the copper-treated plates was a percentage loss of 0.59 per cent from high carbon open-hearth steel, too hard to punch. The pure iron plate came next, with 1.17 per cent, and then the high-carbon Bessemer plate, with 1.77 per cent, the latter also being too hard to punch. The remainder, which were standard steel tie plates, varied from 4.70 per cent to 6.60 per cent, showing approximately eight or ten times the loss in the common or regularly accepted tie plates as for the special copper-treated ones.

This addition of copper naturally results in a tie plate with a slightly higher first cost, but the increase over regular prices will not be over $2 to $3 a ton, depending upon the size of the order and other relative conditions. As a result of these experiments the New York Central Ry. has placed an order for 650,000 tie plates, or 4,000 tons, to be rolled according to the railway's standard specifications, with the addition of 0.25 per cent of copper.

Method of Treating Drill Steel at Copper Range Mines*

By H. T. MERCER and A. C. PAULSON.

To study the matter properly, it was necessary to devise a system of records that would show the actual underground performance of the drills. Reports from each drill machine are made daily by the shop and mine and tables compiled from these reports show the footage drilled, steel broken, drills received and sent out at the shop, drills sharpened, and bits cut off. These data show what each machine or party is doing and whether the miners' supply of drills is kept up to date. The daily records show the number and condition of drills on hand at all times.

The drill formerly used had a cross bit, having a straight taper from the cutting edge, the ends of the wings being straight or square cornered. The cutting edge angle was 90 degrees. With this bit, as soon as the corners became worn, the gage was rapidly reduced; consequently, the hole gradually decreased in diameter, causing the following drill to stick. This meant that the starter must have a gage of 1¾ in. if the 8-ft. drill was to have a bit diameter of 1⅜ in. The sticking also made necessary the use of lugs, which meant more shop work. The Carr bit was next tried. This bit made possible the use of lugless steel, owing to its free drilling qualities, because all points along the reaming edges lie in the circumference of a true circle, so that the gage is maintained even after the corners of the wings are worn.

From drilling experiments, it was found that a reduction of gage 1/16 in. increased the drilling speed about 10 per cent.; therefore, by reducing the gage, a total gain of about 25 per cent was made in the drilling speed. On the other hand, the breakage of steel and the number of bits cut off in the shop was very much more for the Carr bit than for the cross bit. In other words, the "punishment" during the sharpening of the single bit comes mostly in one direction, which tends to flatten the hole, and the process of alternately flattening and reforming tends to strain or split the bit along the cutting edge. This tendency is not so great in the cross bit, because the sharpening blows are more evenly distributed.

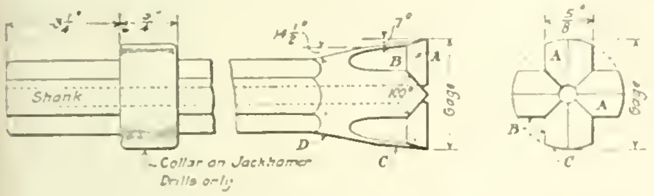


Fig. 1—Dimensions of Drills.

Name	Length as made.	Gage: ⅞-in. steel, inches.	Gage: 1-in. steel, inches.
Starter	3 ft. 0 in.	1 7-16	1½
4-ft. drill	4 ft. 10 in.	1⅜	1 7-16
6-ft. drill	6 ft. 6 in.	1 5-16	1⅜
8-ft. drill	8 ft. 4 in.	1¼	1 5-16
10-ft. drill	10 ft. 2 in.	1 3-16	1¼

Details of the drill now used are given in Fig. 1. The shank is formed in a bulldozing machine, a pin 5 in. long being first inserted in the hole to maintain it. After the shank is formed the pin is removed and the shank reheated and quenched in oil. A 1/64 in. clearance is allowed between the shank and drill chuck. All shanks are made without lugs, except in a few cases where the drills are to be used in loose or "fitchering" ground. Collars are formed on the Jackhammer steel only.

While working with the Carr bit, various heat treating experiments were made. The drills were suspended in a chloride bath and the heat regulated by a pyrometer. They were then quenched in tempering oil, a 10 per cent solution of brine, or water, and tests run on each in the mine under uniform conditions. Other tests were made with a further treatment by tempering or drawing. For example, after the hardening process the drills were again heated in oil to different degrees of temperature for drawing the temper. These experiments proved that nothing was to be gained by an additional treatment after the hardening process, and that there was no practical difference between heating in a chloride bath or in a coke furnace, provided temperature regulation was maintained equally as well in both cases. It was also found that water of a temperature of 80 to 100 F made the best quenching medium for our conditions.

---

*Abstract of a paper presented at the Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers, Aug. 23-28, 1920.

Powder Allowances

Interesting information on the amounts of powder required for certain classes of work at a mine in Mexico is given by Mr. G. L. Schmutz in a recent issue of the Engineering and Mining Journal. At this mine the labor for stoping and development was paid on a contract basis, but the powder was furnished by the company. It was found that an excessive amount of powder was being used, and that a large proportion could be saved. With this in view, it was decided to determine the average amounts of powder used in various kinds of work. It was assumed that a certain fraction of these amounts would suffice for the work. The contractor was allowed an additional price per unit (foot of advance or ton of one broken), represented by the new powder allowance in money. The amount of powder allowed contractors, under the systems, is shown in Table I.

TABLE I.—POWDER ALLOWANCE IN STOPING AND DEVELOPMENT.

	Lb. powder per ton Min.	Lb. powder per ton Aver.	Lb. powder per ton Max.	Lb. powder per ton Min.	Lb. powder per ton Aver.	Lb. powder per ton Max.
Stoping. Cut and fill by machine.						
Silling	0.4	0.5	0.6	0.85	1.05	1.30
Stoping	0.2	0.3	0.6	0.42	0.63	1.26
Square set by machine.						
Stoping	0.20	0.25	0.50	0.42	0.52	1.05
Set—16.5 T.	3.00	4.10	8.00	6.30	8.61	16.80
Top slice by machine.						
Stoping	0.10	0.30	0.50	0.21	0.63	1.05

Development.

	Lbs. powder per ft. Min.	Lbs. powder per ft. Aver.	Lbs. powder per ft. Max.	No. sticks powder Min.	No. sticks powder Aver.	No. sticks powder Max.
Drives.						
Hand	2.0	4.5	7.0	10.5	15.75	24.5
Machine	5.0	8.0	14.0	10.5	16.80	29.4
Winzes.						
Hand	3.0	4.5	7.0	6.3	15.75	24.5
Machine	3.0	5.5	8.0	10.5	11.55	16.8
Station	5.0	7.1	12.0	5.1	15.54	25.2
Raises.						
Hand	3.0	4.5	7.0	10.5	15.75	24.5
Machine	3.0	5.5	9.0	6.30	11.55	18.9

Allowances were made according to the schedule in Table I for a period of three months, at the end of which time the average powder consumption for the period was calculated.

The new averages compared with the old are shown in Table II.

TABLE II—POWDER ALLOWANCES.

Average lb. powder used per ton of ore broken, including waste.

Cut and fill sills Old av.	Cut and fill sills New av.	Cut and fill stopes Old av.	Cut and fill stopes New av.	Square sets Old av.	Square sets New av.	Top slice Old av.	Top slice New av.
0.744	0.492	0.494	0.310	0.387	0.276	0.449	0.205

Development.

Av. lb. powder used per foot of advance.

	Drives Hand. Old av.	Drives Hand. New av.	Drives Machines Old av.	Drives Machines New av.	Winzes Hand Old av.	Winzes Hand New av.	Winzes Machine Old av.	Winzes Machine New av.
	5.77	3.61	9.33	7.39	5.73	2.92	6.80	....
Raises					5.21	3.02	6.79	5.08

Feet of advance used in the calculation of new averages:

Hand drives, 2,100	Hand winzes, 138	Hand raises, 33
Mach. drives, 1,448	Mach. winzes, ...	Mach. raises, 1,518

The rock encountered in this particular mine was principally andesite and latite breccia, approximately equally divided. In addition, there was a small amount of monzonite. The andesite and monzonite were both favorable to good drilling and breaking, but the latite was quite hard. The explosive used in the work would average 35 per cent gelatin dynamite. The holes were not stemmed. Undoubtedly, tamping would have greatly increased the efficiency of the explosive, thereby making it possible to perform the same amount of work with less powder.

Rate Experts Wanted by I. C. C.—The recently authorized increase in freight and passenger rates will make it necessary for the Interstate Commerce Commission to add many expert freight and passenger rate clerks to its present staff. The U. S. Civil Service Commission has announced that examinations will be held throughout the country on Sept. 22 and Oct. 20 for tariff examiners under the Interstate Commerce Commission. Entrance salary is $1,620 a year. The higher administrative positions in connection with tariffs will be filled through promotion.

The Need of a Definite National Program for Development of Great Engineering Problems*

By HERBERT HOOVER.

The time has arrived in our national development when we must have a definite national program in the development of our great engineering problems. Our rail and water transport, our water supplies for irrigation, our reclamation, the provision of future fuel resources, the development and distribution of electrical power, all cry out for some broad-visioned national guidance. We must create a national engineering sense of provision for the nation as a whole. If we are to develop this national sense of engineering and its relations to our great human problems it must receive the advocacy of such institutions as this.

We, together with our sister engineering societies, represent the engineers of the United States. It is our duty as citizens to give voice to those critical matters of national policy which our daily conact with this, the fundamentally constructive profession, illuminates to us. Just as our medical associations voice the necessity of safeguards to national health; as the bar associations safeguard our judiciary, so the engineers should exert themselves in our national engineering policies. We have none, but we need some, or the next generation will face a lower instead of a higher standard of living than ours.

Haphazard Development Must Be Co-ordinated.—The development of our transportation, fuel, power and water under private initiative has been one of the stimuli that have created the greatness of our people. It has been easy to compass when the problems were more local and filled with speculative profits. There, however, arises a time when this haphazard development must be co-ordinated in order to secure its best results to the nation as a whole. This system has given us a 50 per cent result; if we are to have 100 per cent we must have a national conception and national guidance. This last 50 per cent involves problems beyond individual initiative alone.

Not only is individual initiative insufficient because the problems involve political, financial, interstate matters beyond corporate ability, but we have, with practically unanimous consent of the country, adopted a policy of the limitation of profits in the operation of public transportation and power and some other utilities, and through the pressure of public opinion we are rapidly coming to a limitation of profit in the development of other large sections of national resources which tend to become natural monopolies. While the limitations of these profits make for public good, on the other hand they also militate against individualistic development of national resources and necessitate the co-operation of the community as a whole to secure initiative for wider development in the national sense.

Some of the Problems. Certain of our national resources have always been in national ownership, such as waterways. Certain others, such as reclamation, irrigation, distribution of water for power, are rapidly coming under Government control. In others, such as timber, coal, and oil, the possible exhaustion brings their conservation or provision for the nation's future into national concern. In our railway problem national action has until recently been directed wholly to limitation of profits. Latterly it has undertaken to regulate wages and give some small recognition to the necessity of equipment. But microscopic attention has been given to the greater problem of how to get more transportation, to get it so organized as to secure real economic operation in its broad sense.

We have a long list of such problems. Some of these have been discussed before the Institute on previous occasions. I may refer to our discussion of eastern bituminous coal. During the past year the Institute undertook to look into the economic situation of this industry as a national whole. It was demonstrated to be the worst functioning industry in the country. Owing to seasonal and other irregularities of demand, the average term of employment in the bituminous industry is less than 190 days per annum. If this industry could be operated a normal work year 125,000 men could be turned to other production. It is an industry in which 30 per cent more capital is invested than would otherwise be necessary. The cost of coal to the consumer and the risks to the operator are greatly increased, and, above all, it presents a great human problem fraught with all the terrible misery and strikes and justified discontent that flow from intermittent employment.

I am not proposing nationalization of the coal mines; far from it. What is required is that we should realize that with our necessary social view of prohibition of combination there remains a national problem beyond the solution of any individual coal operator or any group of operators. It must have national guidance and national plan for its solution, a co-operation of great consumers, railways, operators, and miners—but what individual operator can do this?

In respect to our coal supplies again, if we would look forward to the next generation, we have a problem of conservation of immense importance. In this connection, it has been ably proposed by our members that the national government should co-operate in investigating the possibilities of the establishment of a great electrical trunk line throughout the great power consuming districts of the northeast, and that we should feed into this great power road power generated at the mines and available water sources, drawing from it at every town and city. The consummation of this project means cheaper power to all consumers. It means a great economy in consumption of coal. It means more regularity in output. It thus means greater ability to compete in world manufacture. It means great relief to the railways from expansion. It means an increased standard of living and a decreased cost of living to a very large section of our population. We have again much such a problem in providing adequate power resources upon the Pacific Coast, where today hundreds of thousands of acres of fertile land are practically non-producing for lack of pumping power.

Of other problems akin to this, we are confronted throughout the west with the fact that a large portion of our average low water supply is already under engagement for irrigation and power. The time has come when that expansion of the land available for cultivation, or into more intensive cultivation, is a factor of mountain storage of water to increase our stream flows in the low season. We have thus a storage problem on a scale we have not hitherto dreamed of, and, again, it is a problem involving co-operation in financial, economic, distribution, navigation—interstate questions, in which individual initiative must have the assistance of the community.

Another series of such problems lies in our oil supplies. If we are to have a mercantile marine and to maintain our navy on a basis of equivalent efficiency with foreign navies, if we are to maintain the development of the gas engine—the greatest lift in our standard of living and saving of labor in 50 years—we are confronted with the necessity of securing additional oil supplies from outside our own boundaries. Our own supplies, so far as now known, do not represent 25 years at our present rate of consumption. The Institute many months ago was the first to give warning to the Federal Government of the gradual absorption of all of the oil sources of the world by other great powers, and that within a short time we should be dependent upon the good will of those powers for our necessary oil supplies. No private individual can compete with foreign governments in the measures that they are adopting to hog the resources of the world. This problem again is an engineering problem that requires more than private initiative.

The Question of Transportation.—A problem of even more pressing importance than these is the whole question of transportation. Our inability to move the commodities which we create is stifling production. It is increasing the cost of distribution and has placed a tax on the American people in decreased production and increased cost of distribution greater than all the taxes imposed by the war.

We have today in Minneapolis ample proof of the frightful cost imposed on the farmer, consumer and public. There is a premium over freight cost from 10 to 20 ct. a bushel for wheat at the mill door compared to wheat in the elevator a few hundred miles away, solely because cars are not available. Either the farmer is losing the amount or the consumer is paying it. Furthermore, to carry the picture further, the railways in endeavoring to remedy this, are diverting cars from the lumber industry. Already certain mills are partially closed; men are thrown out of employment in the mills and in the building trades. Is this not a price in human misery and national efficiency that warrants some national concern? It is a problem that does not lie alone in expansion of railway facilities. It lies also in the proper expansion of waterways and their co-ordination with the railway transportation of the country.

---

*Address delivered Aug. 26 at the Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers.

We have been dabbling in the improvement of water transportation of the United States for 100 years, and so far as I know never yet have we considered it as a problem requiring complete co-ordination of the entire transport problem for the whole country. We have spent enough money improving useless creeks to have made several competent waterways. Every Congressional district in the United States has looked for appropriations for carrying mud from one hole to another as their proper participation in the national plunder. They have never considered that the taxes taken from the people as a whole should be devoted to those points that will benefit the people as a whole.

One result of the policy pursued has been that our waterways have been so badly handled that they have not been able even to compete with the railways, and today, with an enormous increase in railway rates, we find ourselves utterly unable to handle the great bulk commodities of the country at the possible lower charge over our waterways. The opening of the St. Lawrence to ocean-going vessels means 5 ct. a bushel to every farmer in 10 states. Likewise, of no less importance to the people of the entire country are our internal waterways.

National Department of Public Works.—These projects have a simple result in the engineer's mind: they make greater production possible with less human effort; they increase the standard of life; they provide for our children. All these problems are much akin, and the time has come when they need some illumination, guidance, and co-operation in their solution from the Federal Government. Nor do I mean a vast extension of Federal bureaucracy in Federal ownership. If, in the first instance, through an agency of the central government, we could have an adequate study and preparation of plan and method made of these problems of engineering development over the next 50 years, viewed solely in their national aspects, we would have taken the first step toward the adequate provision of an increasing standard of living and a lower cost of living for our descendants.

The second step is to determine that our government will be a government of co-operation, limiting profits surely, but holding to individual initiative as the single hope of human development. In order that we shall have some central point in the Federal government where these problems may be adequately considered, from which they can be ventilated for the verdict of public opinion, where the business brains of the country can be called into conference and co-operation with the government, and therefore with the people, the engineers of the United States have proposed time and again that a cabinet department should be established in Washington, either new or to replace the Interior Department, to which should be assigned the whole question of public works.

You are familiar enough with the advantages of such a department from an every-day administration point of view, and enormous saving to the government from the duplication or competition of the six or seven departments now engaged in engineering construction work of this character, but on this occasion I wish to call your attention to the fact that such a department has become an essential from the point of view of proper consideration and presentation to the American people of these broader national engineering problems, upon which the next generation must depend if our country is to march forward.

Work to Start on Illinois Waterway.—Actual construction work on the Illinois waterway, for which an expenditure of $20,000,000 was authorized in an amendment to the state constitution voted in 1908, will begin the middle of October, it was announced last week by Director Frank I. Bennett of the state department of public works and buildings. The first work will be done at Marseilles and Starved Rock.

Forms and Curves for Recording Stripping Operations

Useful suggestions for recording data in stripping operations are given by Mr. Thomas F. Kennedy in a recent issue of Coal Age, from which the matter following is abstracted.

The overburden removed in the stripping-pit areas is in many instances classified so that monthly records of the excavation can be shown geaphically, as in Fig. 1. The excavation may or may not be classified as shown here. In this case, however, arbitrary figures are assumed for each subdivision, and the total number of cubic yards removed monthly is recorded only of the classified material.

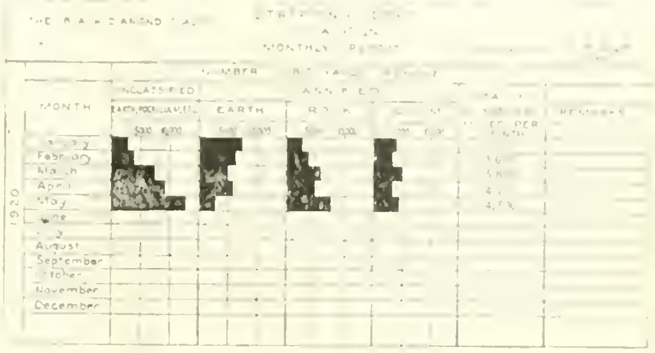

MONTHLY REPORT
MONTH
UNCLASSIFIED
CLASSIFIED
EARTH
ROCK
REMARKS
1920
February
March
April
May
June
August
September
November
December

Fig. 1—Classification Chart Showing by Months Amount of Various Classes of Spoil Removed from Strip Pit.

The most important considerations entering into a stripping proposition—those which interest the engineer most deeply during development—are the number of cubic yards of overburden excavated, the cost of its removal, the number of marketable tons of coal extracted and finally the cost per marketable ton.

In order to show how easily an engineer might keep in touch with the progress of a stripping operation under his charge, a typical problem from beginning to end is illustrated in Fig. 2. This is known as a monthly accumulative chart, and shows, for instance, the total amount of overburden removed to date by monthly intervals between February, 1918, when the operation of stripping was commenced, and February, 1919, when the last of the overburden was taken off. The over burden-cost curve is plotted and shows the total cost from the beginning to the end of the operation. Curves representing the number of marketable tons of coal mined, and the price per ton so marketed also are shown.

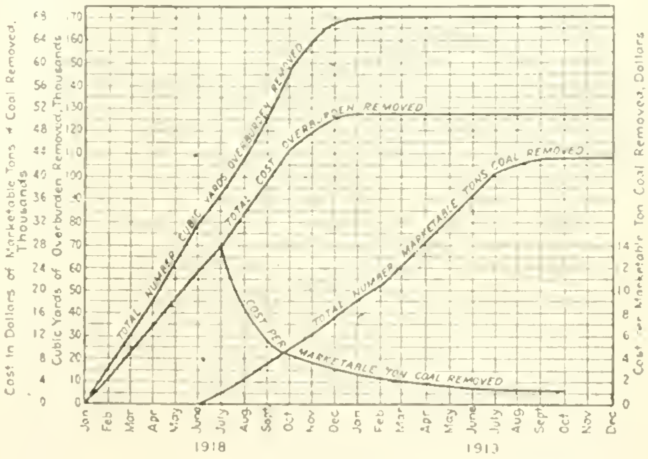


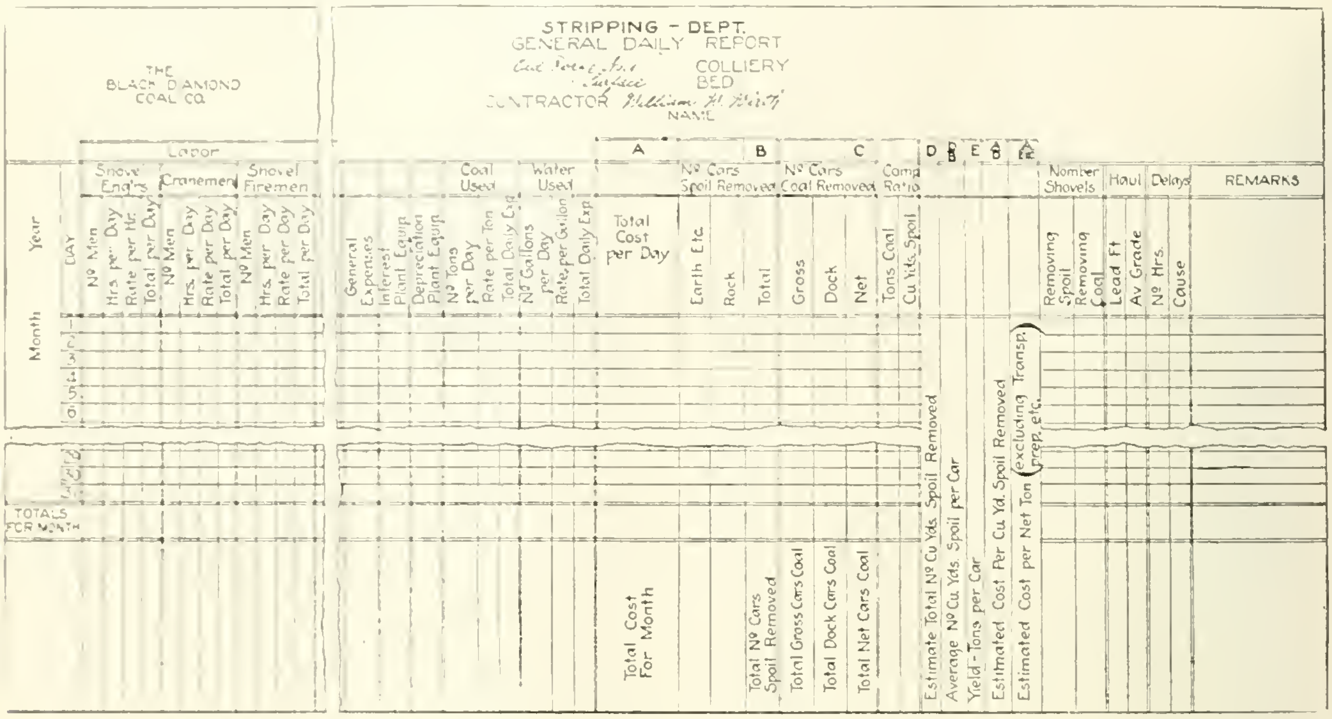
Fig. 2—Accumulative Chart.

The price of unclassified overburden is assumed to be 30 ct. per cubic yard. After six months of operation the chart shows that 2,000 tons of marketable coal have been removed and 92,500 cu. yd. of overburden excavated at a cost of $27,750. The cost of the first marketable ton of coal, charged to the cost of removing overburden only, is equal to the total money paid for the total excavation up to the time when the first ton is removed. But, considering the cost of overburden removed up to and incluning July as $27,750 and 2,000 marketable tons mined in the same month, the cost per marketable ton is found to be $13.875.

In the succeding months, owing to the increasing amount of coal mined, the cost per ton declines until the last ton of coal is removed in October, 1919. The last cubic yard of overburden was removed in February, 1919, when a total of 170,000 cu. yd. was excavated; the total cost at 30 ct. per cubic yard would thus be $51,000 as shown by the overburden cost curve; the total number of marketable tons mined was 43,000, which shows that the cost per ton due to overburden removal alone was $1.186.

In conducting a stripping operation the average contractor nowadays depends upon his experience and good judgment. He usually is tied up to several jobs, with the result that he appears on the scene of each only once or twice a week to investigate how things are going. He gives the job the "once over" and talks with his superintendent or foreman, who was formerly a good shovel runner or bookkeeper. The usual result is that the contractor, owing to an unpresentable form or record of data concerning the daily cost of his plant and operation, in many instances is totally at sea and trusts to his good judgment and good luck that he will come out ahead at the end of the month. Contractors on large operations especially should employ an experienced engineer who can analyze and study daily the various items of expense that make up the cost per cubic yard. It is unnecessary to state that the expense of employing an engineer will be returned many fold to the contractor.

For the foregoing reasons, from both the contractor's and engineer's points of view, it is necessary that some system for intelligently and methodically co-ordinating the different factors, costs, etc., of a stripping proposition should be instituted. In Fig. 3 a general daily stripping report (abbreviated) is offered. This shows the different factors, among which labor is probably the most important. This is mainly composed of wages paid to superintendent, foreman, shovel engineers and firemen, cranemen, pitmen, dumpmen, laborers, dinkey engineers and firemen, brakemen, drillers, blacksmiths, helpers, watchmen, machinists, time keepers and teams.



THE BLACK DIAMOND COAL CO.

STRIPPING - DEPT.
GENERAL DAILY REPORT
COLLIERY
BED
CONTRACTOR *William H. [illegible]*
NAME

Year | Month | DAY

Labor: Shovel Eng'rs — Nº Men, Hrs. per Day, Rate per Hr., Total per Day | Cranemen — Nº Men, Hrs. per Day, Rate per Day, Total per Day | Shovel Firemen — Nº Men, Hrs. per Day, Rate per Day, Total per Day

General Expenses | Interest Plant Equip. | Depreciation Plant Equip. | Coal Used — Nº Tons per Day, Rate per Ton, Total Daily Exp. | Water Used — Nº Gallons per Day, Rate per Gallon, Total Daily Exp.

A: Total Cost per Day

B: Nº Cars Spoil Removed — Earth Etc., Rock, Total

C: Nº Cars Coal Removed — Gross, Dock, Net

Comp. Ratio — Tons Coal, Cu. Yds. Spoil

D: Estimate Total Nº Cu. Yds. Spoil Removed

Average Nº Cu. Yds. Spoil per Car

E: Yield - Tons per Car

Estimated Cost Per Cu. Yd. Spoil Removed

Estimated Cost per Net Ton (excluding Transp., prep. etc.)

Number Shovels — Removing Spoil, Removing Coal | Haul — Lead Ft., Av. Grade | Delays — Nº Hrs., Cause | REMARKS

TOTALS FOR MONTH

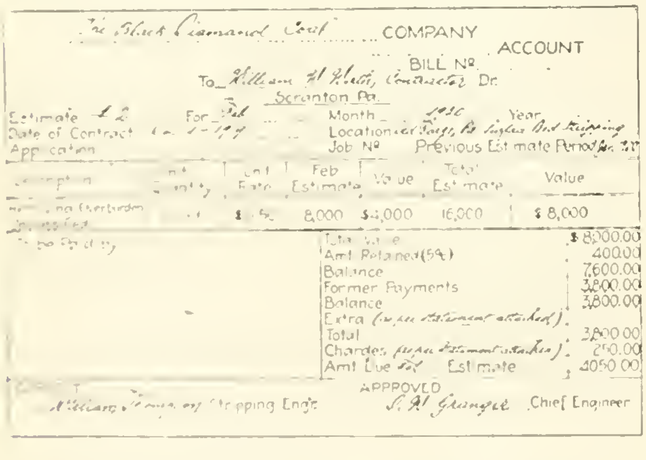
Total Cost For Month | Total Nº Cars Spoil Removed | Total Gross Cars Coal | Total Dock Cars Coal | Total Net Cars Coal

Fig. 3—General Daily Shipping Report.

From a study of the report the factors of most importance to the contractor and engineer are the columns designating total cost for month, total number of cars of spoil removed, estimated total number of cubic yards removed and estimated cost per cubic yard of spoil removed. The last item fixes the profit—or loss—of the contractor and should be reduced to a minimum.

With this form of report the higher items of expense can be singled out at a glance and given careful study. Consequently some plan for reducing them can be recommended. If the contract is for removing coal, the column marked "total net cars of coal" also is of significance, while that headed "estimated cost per net ton," arising from the cost of stripping overburden only, directly concerns the company's engineer. In addition to the foregoing charts and curves a form for the contractor's bill is shown in Fig. 4.

In conclusion it might be said that each stripping has its own characteristics and that special curves are valuable in the study of the problems encountered. The few suggestions offered, however, can be applied to almost any stripping.



The Black Diamond Coal COMPANY
ACCOUNT
BILL Nº
To *William H. [illegible], Contractor* Dr.
Scranton, Pa.

Estimate *4-2*	For *Feb*	Month *1920*	Year			
Date of Contract *[illegible]*		Location *[illegible]*				
Application		Job Nº	Previous Estimate Period			
Description	Quantity	Unit Rate	Feb Estimate	Value	Total Estimate	Value
Removing Overburden [illegible]		$ .50	8,000	$4,000	16,000	$ 8,000

Total Value	$ 8000.00
Amt. Retained (5%)	400.00
Balance	7600.00
Former Payments	3800.00
Balance	3800.00
Extra *(as per statement attached)*	
Total	3800.00
Charges *(as per statement attached)*	250.00
Amt. Due *for* Estimate	4050.00

APPROVED
William [illegible] Stripping Eng'r. *S. H. Granger* Chief Engineer

Fig 4—Suggested Form for Contractor's Bill.

Comparison of Dredging Quantities in Place and in Scows.—An interesting comparison of quantities of materials in dredging work when the material is measured in place and in scows is given in a recent issue of The Canadian Engineer. The cut was through mud, silt and clay carrying about 32 per cent of moisture. The scows were always well filled and the work was done conscientiously. The material removed, taking place measurement, was 31,680 cu. yd., and according to scow measurement it was 53,100 cu. yd. This means that 21,420 cu. yd. of water, or 40 per cent of the scow quantities, were removed with actual materials, and that 60 per cent of scow measurement might be taken as a basis for check measurement. That is

	Per cent.
31,680 cu. yd. actual material	= 60
21,420 cu. yd. water	= 40
53,100 cu. yd. material, scow measurement	= 100

Blasting Granite With Compressed Air*

By OLIVER BOWLES
Mineral Technologist, Bureau of Mines

The introduction into mines, quarries and manufacturing plants of machines and tools operated by compressed air has revolutionized methods of operation to an extent comparable only with that occasioned by the invention of explosives and the utilization of electricity. The use of compressed air in pneumatic tools, in rock drills, and for the operation of pumps and other machinery is well known to most miners and quarrymen, but its application as a substitute for explosives for breaking rock in a few granite quarries has received little publicity.

In the region of Lithonia, a few miles from Atlanta, Ga., is a dome of massive granite used widely for building stone and for paving blocks. The most remarkable structural feature of the granite is the absence of joints and sheeting planes. The term "joints" is applied to open fractures that commonly occur in rocks, usually vertical in direction or nearly so, and spaced from a few inches to several feet apart. On the Lithonia granite outcrop, however, one may walk over the bare rock surface for hundreds of feet without finding any indications of a joint. "Sheeting planes" are open fractures at various levels, approximately parallel with the rock surface. The presence of such planes when spaced several feet apart greatly facilities quarrying and where absent, as at Lithonia, the necessary fractures must be made artificially.

The forcing of artificial sheeting planes is accomplished as follows: Two holes of about 3-in. diameter are drilled close together and to a depth of about 8 ft. Two men work at these holes all summer, and sometimes part of a second summer. A very small charge of black blasting powder, not more than a spoonful, is placed in each hole, tamped with clay, and the charges are fired simultaneously with an electric battery. This starts a small fracture running outward from the bottoms of the holes. There is in most granites one direction of easy splitting known among quarrymen as the "rift," and as the rift direction in the Lithonia granite is horizontal the fracture follows a horizontal plane.

After this preliminary shot water is poured into the holes to soften the clay tamping which is then removed, and second charges, a little larger than the first ones, are placed in the sand holes. This process is repeated time after time with a gradual increase in the size of the charges, and the fracture gradually widens. A quarryman skilled in this type of work can readily judge the extent of the fracture, for when standing on the rock surface at some distance from the drill holes he can determine by the nature of the jar beneath his feet when the charges are fired whether or not the fracture has reached the point over which he is standing.

Solar heat is said to assist greatly in this process. It is claimed that during the hottest part of the summer the fracture will extend without the assistance of explosives. In fact, solar heat is found to be of such material advantage, that it is deemed advisable to suspend operations during the winter months.

There is nothing spectacular about this type of blasting for the charge is never large enough to disturb the tamping. If one places his ear on the rock surface at a distance of 25 or 30 ft. from the drill holes the only evidence of the explosive discharge is a faint thud similar to that produced when one rests his head on a table and taps the under surface of the table top with his finger tip.

This process of blasting with increasing charges is continued until the outward boundary of the horizontal fracture forms a circle 0 to 680 ft. distant from the central holes. Any attempt to hasten the operation by increasing the charges too rapidly would be disastrous, for it would result in forcing a vertical fracture, and thus render further continuance of the process impossible.

The final step, involving the use of compressed air, is the most interesting of all. An iron pipe is placed in each drill hole and the space between the pipe and the rock filled in with sand bags and melted sulphur so that it is air tight. Connections are made from the iron pipes to the air compressor equipment which is employed to supply air to the quarry drills, and compressed air is thus transmitted at a pressure of about 100 lb. to the square inch. The effect is truly remarkable, for as the air enters the narrow confines of the artificial sheeting plane, with a crackling, rending noise it widens the fracture until it emerges at the surface at some point on the flank of the rock dome. The sheeting plane thus formed may cover an area of one or two acres.

At first sight it seems incredible that air at a pressure of only 100 lb. per square inch could execute so tremendous a task. A little calculation, however, will make it seem more reasonable. Assuming that through leakage or for other reasons the air pressure drops to 50 lb. per square inch, the total upward pressure on a circular mass of rock 120 ft. in diameter would be over 40,000 tons, while the actual weight of such a mass of rock 8 ft. thick would be only about 7,200 tons. Thus the lifting pressure would be nearly 6 times the weight of the rock mass, and this is evidently sufficient to force a continuance of the fracture already begun with explosives.

The mass of rock 8 ft. thick and one to two acres in extent is then ready for subsequent quarry operations, and one such mass may occupy many workmen for an entire season. Cross fractures are made by using "plug and feather" wedging in holes 5 in. apart and 5 in. deep. Masses of rock about 8 ft. wide, 8 ft. thick and many feet long are first broken out, and these are subsequently further divided.

The absence of joint planes makes it possible to procure rock masses of any desired size. One mass observed was 8 ft. thick, 7 ft. 8 in. wide and 375 ft. long with no cross fractures. Such a mass would weigh about 1,870 tons. In so far as utilization of the product is concerned, any possible advantage to be gained from the ability to obtain exceedingly large blocks is entirely lost, for most of the rock is subdivided and again subdivided until it is reduced to building stones and paving blocks.

The employment of compressed air in breaking rock in the manner described does not bear promise of any radical change in general quarry practice, for its application is greatly restricted. Most rock ledges are intersected by numerous joints which in many instances are so closely spaced that blocks suitable for building or paving cannot be obtained, and the rock may be utilized for crushing purposes only. It is obvious that any open fracture in a rock mass would provide a means of escape for the explosive gases generated during the early phases of the process described above, and thus render it ineffective, and would also permit the escape of the compressed air used in the final operation. Thus the method may be used only where the rock is free from joints, and such rock masses are of rare occurrence.

---

*Reports of Investigations, U. S. Bureau of Mines, August, 1920.

Long Life of Wood Poles Set in Concrete

A recent issue of Electric Traction furnishes an example of the value of setting wood poles in concrete. The experience is that of the Topeka Ry., Topeka, Kan. A portion of this line was originally electrified in 1888 and the city lines were first operated by electricity in 1902 and 1903. The overhead work at this time was constructed with unusual care and precision, the line being located with plumb bob and transit. The first trolleys used were made of wood and every precaution was taken to insure an unfailing contact.

At corners and at places where unusual stresses occurred, an effort was made to make the overhead construction as rigid as possible. This feature of the construction in 1888 manifested itself in the use of 30-ft. poles with a minimum top diameter of 10 in., at all turns in the line. In the attempt to secure rigidity, these heavy poles were set in concrete. All of these corner poles except those which have been broken through accident are still in service after 32 years, in spite of the fact that the concrete was of a comparatively poor quality on account of using a local cement which at that time had not been developed to a high degree. The illustration shows one of these poles near the business section of Topeka.

The value of proper setting of wooden poles is clearly demonstrated by these 32-year-old poles. In this section of Kansas the average life of unprotected wood poles is 8 to 10 years.

Method of Making Soundings Through Ice

A method of making soundings through ice, water and mud, by using lengths of small pipe, was described by Mr. John C. Trautwine, 3rd, in a recent issue of the Cornell Civil Engineer. The surroundings were made to determine the kind and thickness of cover over a mine extending under a lake. The mine (see Fig. 1) has its mouth, M, perhaps within 100 ft. of the shore of a lake. The lake is about 1½ miles long and ½ mile wide, and the ore has been worked out from the vein to a point at least ⅓ mile under the lake, as shown at B.

The mine dips down at about 20 or 30 from the horizontal. Near its mouth, the top or roof of the mine approaches very closely to the bottom of the lake, as had already been ascertained by soundings and the mine surveys—perhaps to within 10 or 15 ft., as indicated at D. Further down, however, the indications were that the roof covering of solid rock was thicker, and the probabilities were that the greater the distance into the mine, the greater the thickness of solid rock constituting the "roof." Apparently, the most critical point had been reached at about D. Nevertheless, soundings had never been made more than 100 ft. or so out into the lake, and there was no real indication of the safety of the mine; and to have the lake break into such a mine, which could afford but one general avenue of escape, would have been a very serious matter, especially if the waters were to rush in at all rapidly.

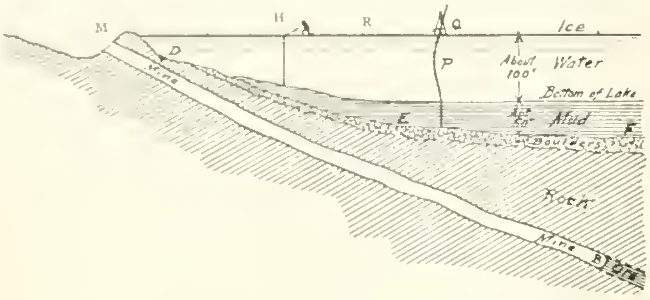


Fig. 1—Cross Section of Mine and Part of Lake.

Early in 1912 a cold snap set in and the lake was soon covered with ice thick enough to enable a party to go out on it with a transit, if necessary, and lay off on it a "checkerboard," and make soundings through the ice—a far cheaper method, of course, than that of making the soundings from a boat, with the accompanying necessity for one or two transit parties on shore to locate the boat. Colored tags, lettered and numbered, were used to mark the "stations," and were literally nailed down to the ice with large nails.

The soundings through the water were made with a wire, to the end of which was attached an old drill to act as a "sinker." No windlass was used for handling the wire, the wire being cut off into fixed lengths of 100 or 200 ft., and the upper end of the wire being then laid out along the ice horizontally between "stations." The sinker was then lowered by one man through a hole, H, Fig. 1, in the ice, and a second man, R, holding the other end of the wire, walked, or frequently ran and slid, along the ice, until the sinker reached the bottom as would be indicated by the slackening of the wire. On taking up the slack, a simple measurement with the steel tape, from the other end of the wire to the appropriate "station," would give directly the depth of the water under the hole.

However, the data obtained from these soundings, though more than covering the mine, gave evidence that they in themselves were not reassuring as to the safety of the mine. All but the edges of the lake, as indicated by the "feel' of the sinker through the wire, and as shown by the material brought up by the sinker, was covered with a sedimentary deposit of soft mud. In fact, the drill, if dropped rapidly, would come up (if the wire did not break and leave it down there, as happened several times), with mud clinging to it for a length of a foot or more. The material was very soft, was finely divided to the point of feeling slimey, and seemed quite homogeneous; but examination under a microscope revealed a display of brilliantly colored fragments rivaling a kaleidoscope. Moreover, the entire middle third of the lake was level enough to build a tramway on (though the tramway would have sunk in and disappeared!) while there was no such level tract of ground within many miles. Indeed, judging from the surrounding hills, the indications were that the real rock bottom, toward the middle of the lake, possibly lay 100 ft. or more below the surface of the mud.

In spite of the continued cold, which showed no signs of letting up, it did not seem wise to plan any ideal apparatus or to send to New York City for supplies for the purpose of attempting to sound down through the mud to solid rock. The reverse process was therefore used, of taking what could be found on the spot, and making the best of it. Fortunately but little seemed to be needed to make some kind of a try. A good supply of "two-by-fours" enabled the helpers, who were carpenters, to construct in the course of a morning a crude 10-ft. derrick. They put a couple of wooden runners under it, and steps up on one side, while the blacksmith stopped sharpening drills long enough to twist a bar of iron into the shape of a windlass which was attached to the side of the derrick, and a pulley was attached near the top. By postponing the installation of the steam radiators in some new buildings, an ample supply of ¾-in. or 1-in. pipe was available.

The plan was, of course, to sled the derrick along the ice, adjust it over a hole, and lower one pipe length after another into the water down to the mud. As the combined lengths were lowered, a man climbed up the derrick with a new length of pipe, and screwed it onto the top of the assembled lengths below. This process was repeated until the pipe would go down no further. Before lowering the pipe, a rope was lashed to it, run up over the pulley, and back down to the "windlass," where it was given three or more laps (for the ice greatly reduced its coefficient of friction), so as to be able to pull the pipe out again. As new lengths of pipe were added, the rope was shifted to the new upper end so produced.

Having observed how beautifully a pile can be driven into sand by means of a jet of water alongside, and feeling that the mud was somewhat akin to sand, a pump was at first taken out with the outfit, and connected by means of flexible hose with the top of the pipe, after the pipe had reached the mud. Possibly this might have been made to work well if spare time enough had been available to keep the pump continuously manned to prevent it from freezing; but even when it did work, it did not seem to help the pipe down very much, perhaps because a high enough pressure could not be procured.

But, as is well known, a cork, once started twisting, can easily be withdrawn from a bottle. So the pipe was twisted with a pipe-wrench, and it was found that it went down through the mud surprisingly well. In Fig. 2 the man on the right is seen holding the wrench, the one in the middle has hold of the crank on the windlass, and the one on tha left is holding the slack end of the rope.

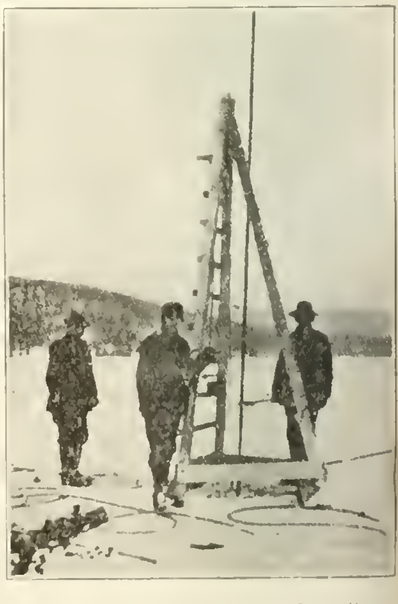


Fig. 2—Arrangement for Sounding Through Ice With Pipe.

Early in the work, while still not far from the shore, the pipe would sink 5, 10 or 20 ft. or more, through the mud, before its lower end could be heard gritting on the rock below, and it would refuse to go down any further. In such places the water depth was not very great. But something like a third of the way across the lake, the water depths had approached, and in some places exceeded 100 ft. A column of 1-in. pipe, 100 ft. tall, would hardly be considered of ideal dimensions for drilling holes over 50 ft. deep, even in soft mud. Yet that was what was actually accomplished. As soon as the pipe bore on the mud, the portion that projected above the ice, would begin to depart from the vertical as was let down. One or [illegible] such columns of pipe were broken off, but it was soon [illegible] that it was possible to lower the upper end until the top would lean over perhaps 15° or more from the vertical. Presumably the condition was about as shown at B, in Fig. 1. Lowering would then be stopped and the pipe wrench applied. Usually a half dozen twists would straighten the upper end to nearly vertical, which indicated that the lower end had gone on down and that the column was presumably nearly straight. The upper end, then, was supported by the rope, the middle portion partly depended from the upper portion and was partly supported by the lower portion, while the weight of the lower end alone exerted all the force available for penetrating the mud. Then it was lowered again until the upper end leaned about 15°, and the pipe was twisted again until it was straight, or until it hit the rock.

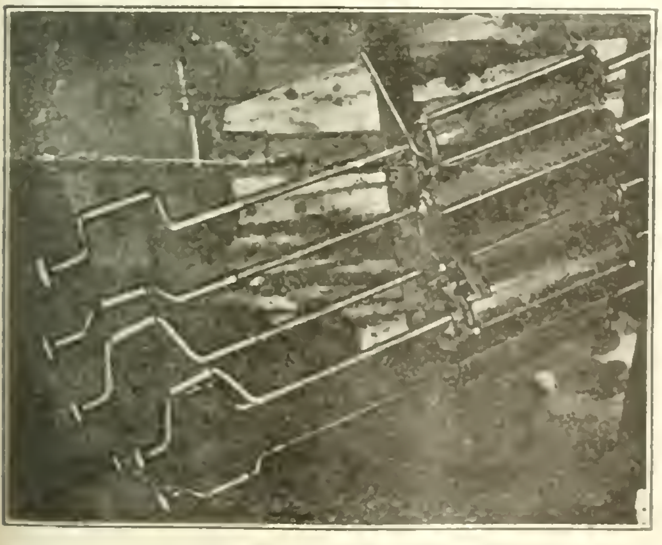
Sometimes after gritting a little there would be a jar and the upper end of the pipe would straighten once more. This indicated, of course, that a small rock had been encountered but had been passed. Usually, the second time the gritting began it would continue indefinitely as long as the pipe was twisted.

The extracting of the pipe was about as tedious a process as the sinking of it, for the pull was severe, even though assisted by twists from the pipe wrench, and the 1-in. rod constituted none too small a windlass drum for the 1-ft. crank. Also, the pipe length had to be disconnected one by one, a procedure all of us shunned, because of the water that was released from the top length of pipe as it was unscrewed. Toward the middle of the lake, where the water was 100 ft. deep, and the pipe generally penetrated 50 ft. of mud, and in some cases 60 ft. and a little more, only two or three complete soundings could be made in the course of a day.

The Grease Gun for Lubrication on a Dredge

Large bearings working under heavy load and so placed as to be inconvenient of access entail a real problem from the lubrication standpoint. Where such bearings operate under conditions that might permit the entrance of sand, the use of grease for lubrication and the filling of the entire bearing space with the grease effectively keep out sand.

The lower tumbler on the bucket line of a gold dredge, as well as the rollers supporting the upward-moving bucket line, furnish an excellent example, states Engineering and Mining Journal. Both lower tumbler bearings and the bearings of the rollers are lubricated with grease. The grease is applied with a grease gun, which consists of a cylinder filled with grease into which a piston is forced down by a screw discharging the grease through a small pipe which is attached by a threaded end to an opening in the bearing. After charging a bearing the opening is closed by a screw plug. The illustration shows a set of grease guns on one of the gold dredges of the Yuba Consolidated Gold Fields Co.



Grease Gun Used on Gold Dredges.

State Regulation of Public Utilities vs. City Council Control

Engineers are [illegible] both by [illegible] to observe, study and form an [illegible] as to the relative merits of the present [illegible] system of state regulation contrasted with the old and practically obsolete system of city council control [illegible] in preventing the nonfunctioning or the [illegible] utility service. For this reason a recent report on this subject by the Public Affairs Committee of the Western Society of Engineers is of much interest. While the report deals particularly with the situation in Chicago, where there is considerable agitation for doing away with the State Public Utilities Commission, it contains facts which should be known and kept in mind by all citizens. The report follows.

The old method of securing the service and establishing the rates of a utility in a city was the natural but primative one of forcing the utility to make the best bargain it could with the city council, the bargain being expressed in the form of a franchise or "contract" ordinance. No utility at its start was a public necessity, since the public had to be taught its usefulness and desirability. Therefore, both the service and the rates were unimportant. The promoting company's chief aim was development and this was impossible if service was poor and rates too high. In other words, the company was its own regulator and at first the general public was only slightly interested in its rate of profit.

The old system, like any commercial bargain not based on costs, resulted in poor service where rates were too low, extravagance and corruption where they were too high, and the worst kind of local "politics" and practices. In either case the public failed to get what is now looked upon as essential—good adequate service at a fair rate.

The old system, as a matter of fact, was fundamentally unfair. The citizens elected the city council to represent them in the bargain. The owners of the utility company similarly elected directors and officers to represent them. Obviously a "square deal" required a third party, as judge, to whom each side could present its arguments for an impartial decision, fair to both sides. The general public is willing that the decision should be fair. The old system makes no provision for such a result.

The old system has proved a failure after long trial, not only for reasons suggested above but also because it left the service using public helpless against either poor, inadequate service or unjust rates during contract periods. The attempt to get what rates would fairly cover costs during such periods was as unsuccessful as it was unscientific and uneconomic.

The new system of state regulation of service and rates by a commission is the natural and logical outgrowth of the attempt to remedy the obvious and unbearable faults of the old system. Except as to railroads, this was started in Massachusetts in 1906 or only 11 years ago, and in Illinois in 1911. At the present time regulation by commission is in effect in 12 states and in the District of Columbia, Hawaii, Porto Rico, and the Philippines. The Texas League of Municipalities, composed of mayors, is formulating a statute for presentation to the next legislature. There are five commissions in Canada.

It is pre-eminently the American system for handling utility companies in the interest of the public. Its growth has been slow but steady and no state which has adopted it has seen fit to repeal the law and go back to the old and practically obsolete system of municipal council control.

"Home Rule" so called, as now proposed is but a proposition to popularize the old system by giving it a good name. It does not contemplate placing the responsibility upon an independent and impartial commission employed to devote its time to such matters, but proposes to continue the handling of public utilities in the old political channels where partisan interests are in position to exert unduly potential influences.

In our opinion, the only thing which has saved any semblance of adequate utility service in Chicago under present cost conditions was the fact that the "contract ordinances," established by the city council under the old system, and still fought for by the city administration, could legally be broken and overruled by the action of the State Commission under the working of the new system. The fallacy of "contract rates" for public service has at length been fully demonstrated.

The public might benefit under the old system except for two important facts: first, good service is more important than a low fixed rate in any city; second, no utility company can be forced to do the impossible, i. e., to give good service, or any service at all adequate, after its receipts cease to meet its expenses. It is our opinion, therefore, that a successful attempt to continue "5-cent fares" and other pre-war utility rates, regardless of costs, would be nothing less than a calamity to the city as a business and social center.

In view of the above, the fact that the Illinois Utilities Commission has recently granted rate increases, after due public hearings and argument, to Illinois utilities, is to its credit and makes for the ultimate good of the public rather than otherwise. The service using public apparently realizes this since it is not generally complaining as to the new rates so much as to poor or inadequate service.

Opposition to control of utilities through state commission seldom, if ever, takes the form of objection to any feature of the regulatory law under which the commission acts. There is opposition to having a commission at all, and opposition to its personnel; but no acts performed by the commission under the law, and under its oath of office, are pointed out as against public interest or as being unfair and unjust. The public is safeguarded from possible illegal or unjust acts of the commission by the fact that such acts are always subject to court review. The present Illinois law provides for a bipartisan commission. It was enacted under a Democratic administration and is now operated under a Republican administration. On this basis the Illinois commission holds an enviable record for its effort to interpret and carry out the law as written in the public interest.

There are 42 state commissions in the United States, and five commissions in Canada, and they have found it necessary, and to the public interest, to raise utility rates since the war. It is not a local issue; nor can the Illinois commission be pointed at as a special offender in this regard, as some are trying to make it appear. Pre-war rates are now as impossible with utilities as with other necessities.

The oldest labor paper in the United States, the Union, published in Indianapolis, recently contained the following very practical and sensible summing up of present conditions affecting utility rates of the telephone companies:

> Now the telephone service vendor is subject to the same human conditions as the merchants in any other line. It buys certain commodities and turns these commodities into what it sells to the public. If it can buy copper and steel and chemicals and property and labor at a certain price it can sell its product in service at a price which is fixed by its expense plus the profit allowed it by a public body. If the cost of the materials used in the production of its service increases a hundred per cent or more, would it not be quite reasonable to expect that it might and should be allowed to increase the costs of the service sold in the same proportion? And if such proportionate advance in rates is not allowed, can we expect the telephone companies to render service on a standard set or a profit making basis?

The same argument applies to all utilities. The basis of old time rates has changed with the tremendous changes in wages and other costs. This fact seems to us self-evident and to dispose of most of the argument to restore so-called "Home Rule" so as to get back the old "5-ct. fare." It cannot be done under the old system any sooner than under the new. And service, the really important factor to the citizen, will be jeopardized by such a reactionary change.

The commission has performed its proper duty in increasing rates to meet present conditions and will be an equally effective agent in decreasing them should conditions warrant reductions in the future. The utility is thus maintained at all times as an efficient going concern and enabled and compelled to give good service with fair but not excessive returns to both labor and capital. The machinery to accomplish all this is supplied by the commission.

Any attempt to impair the usefulness of the commission, to abridge its powers, and especially to go back to the old era of political control of utilities, in vogue prior to the time when commission regulation became the law, would be a distinct step backward; a grave menace to the industries of the state and to its people. The recent increases in rates were only the normal consequence of the increased cost of all commodities, and were far less, as a rule, proportionately, than the average increase of commodity costs.

Economical Method of Thawing Dynamite

A simple, economical and safe method of thawing dynamite, and incidentally one which greatly adds to the comfort of men on shift, is described by Mr. Douglas Lay in the Engineering and Mining Journal.

A change house or lunch room of sufficient size to accommodate the miners and others on shift is erected close to the portal of working tunnel, or shaft collar, as the case may be. A large box stove in this building is supplied with a hot-water coil, by means of which a horizontal water coil is heated in a thawing box, situated in a small building about 100 yd. from the change house and placed at as great an elevation above the latter as the profile permits. The two water pipes between the two buildings are placed in a wooden box filled with hay or straw, the box being buried about 18 in. below the surface of the ground.

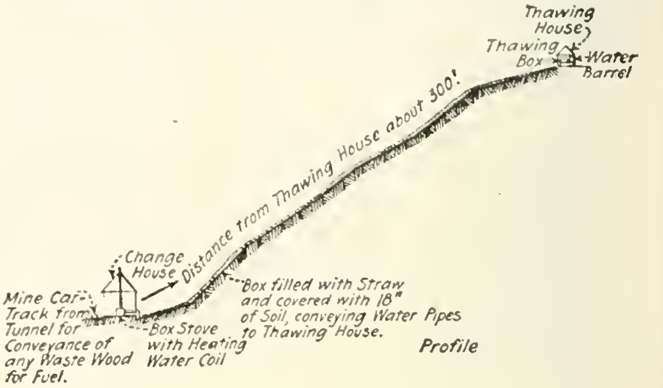

Thawing House
Thawing Box
Water Barrel
Distance from Thawing House about 300'
Change House
Mine Car Track from Tunnel for Conveyance of any Waste Wood for Fuel.
Box Stove with Heating Water Coil
Box filled with Straw and covered with 18" of Soil, conveying Water Pipes to Thawing House.
Profile

Fig. 1—General Arrangement of Change and Thawing Houses.

The essential idea in the placement of the two buildings is that if the change house catches fire, the latter cannot possibly spread to the thawing house. At the same time, although the method of thawing dynamite is comparatively safe, such a building as the thawing house should always be placed in an isolated spot, taking advantage of any natural protection afforded by ground contour, so that any untoward happening therein is not likely to cause loss of life. The above general arrangement is illustrated in the sketch, Fig. 1.

The size of the change house and lunch room depends, of course, upon the number of men it is desired to accommodate. Around the sides of the interior is a seat 15 in. wide, with a foot rest in front 21 in. in width. With this exception the building contains no floor, the soil being merely leveled off, with perhaps a layer of fine waste scattered over it. This ensures absence of danger from any hot ashes from the stove. A brick chimney for the latter is highly advisable, but if a stovepipe is used care should be taken to insulate it thoroughly. Most stovepipes are a constant menace unless run into brick chimneys. In the center of the building is a large box stove, the larger the better, which contains a heating coil. The top of the stove serves to heat tea and coffee.

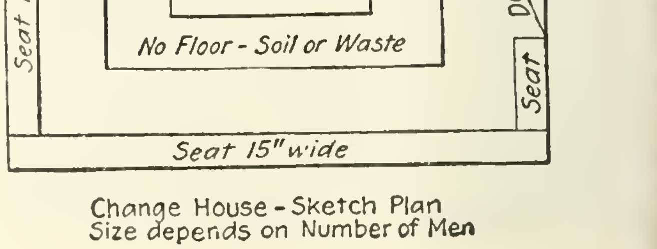
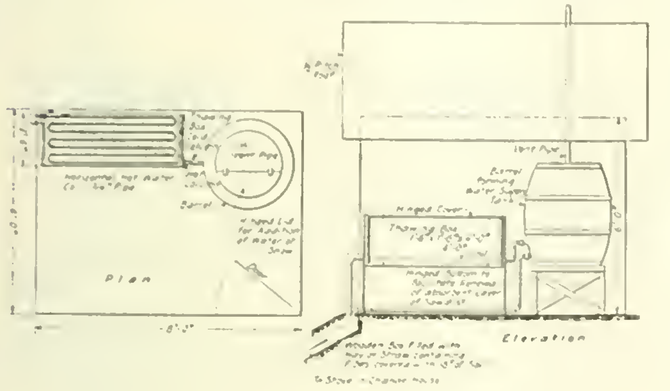


Fig. 2—Plan of Change House.

The building coatains no ceiling [illegible]. It is preferable to place the building at the side of a [illegible] track so that any waste wood from the mine or timber yard, e.g., ends of timbers, old wedges, and similar material may be readily conveyed to the change house and utilized as fuel. The general arrangement is shown in Fig. 2.

A convenient size for the thawing house is 8 by 6 ft., with 6-ft. walls and half pitch roof, sufficient to accommodate thawing box, water barrel, and a few unopened boxes of dynamite. (See Figs. 3 and 4.) The thawing box is made of 2-in. plank, and is 18 in. wide by 18 in. deep by 4 ft. long. Filling the bottom is a coil of [illegible] in. pipe over which a layer of sawdust, which acts as an absorbent of any exuded nitroglycerine, is sprinkled. The box has a hinged, tightly fitting cover. The sticks of dynamite are put in the box without any definite order, the idea being that they will criss-cross and so permit of efficient distribution of heat from the coil. The bottom of the box is hinged and opens downward, so that the sawdust may be renewed periodically. With this arrangement, the operation of removing old sawdust and putting in fresh occupies two or three minutes only. Obviously, attention should be paid to this matter of changing absorbent. The bottom of the thawing box is set 18 in. above the floor of the building. The water-supply tank consists of an old oil barrel, which is provided with a vent pipe to outside, so that no steam is liberated in the building. A hinged cover permits of ready addition of water to compensate for evaporation. If the weather is sufficiently cold to require the thawing of dynamite, there is usually an abundance of snow adjacent, so that it is convenient to use this for the purpose instead of water.



Figs. 3 and 4—Plan and Elevation of Thawing House.

Locating Flaws in Rails*

The treacherous flaws occurring within steel was one of the problems encountered by our rifle makers during the war. The problem of producing a flawless steel was therefore put up to the Bureau of Standards at Washington and was referred to the expert in magnet analysis who had been studying the relation between molecular and magnetic properties of steel for over eight years. This expert has produced an instrument which magnetizes steel. If it is run along a steel bar that is absolutely uniform in quality inside and out the needle of the dial of the instrument does not move. If the needle does move it indicates that there is something wrong somewhere within the steel bar.

It is now proposed to use this instrument, called a direction finder, to test the uniformity of bridge members and other structural steel and also to locate flaws in rails. Flaws within steel rails, which cannot be detected by inspectors nor provided for by engineers when designing steel members and rails, have been the cause of many serious accidents. Serious railway wrecks are often attributed to flaws in rail. Therefore the introduction of an instrument which can be used in testing rails to locate serious flaws is a long step toward safety in railway operation.

It is reported that one of the large eastern railroads is now planning to make use of the magnetic tester in testing its rails, especially those newly purchased. The results accomplished by this means of testing will be closely watched by all railway men.

---

*From Electric Traction

How to Obtain Best Results from Hammer Drills*

By HOWARD R. DA[illegible]

Best results from hammer drills may be obtained by giving close attention to two factors in drill maintenance. They are of equal importance: one is lubrication, and the other is care of the shank.

With the exception of stoping drills, most modern rock drills require both oil and grease. The oil ports are in the lubricator, on or behind the hammer cylinder; the grease port for the lubrication of the chuck sleeve and rotating mechanism is on the chuck end. Ordinary machine oil is not adapted to rock drills; a heavier more gelatinous oil such as castor machine-oil or liquid grease should be used.

The lubricators should be filled once for every 12 or 14 ft. of hole drilled. Grease guns should be used to fill the port in the chuck end once a shift, a medium grease is well adapted to this purpose. Hard grease must not be put into the lubricator, as it will not flow through that part. Contrary to the popular belief, oiling a machine once or twice a shift does not provide sufficient lubrication; the drill should be oiled once for every 12 or 14 ft. of hole drilled.

The rotating handle of a stoping-drill is an oil-reservoir and is provided with a port for oiling. The rotating handle is packed with wicking, or similar material, which causes the oil to feed slowly from the handle to the other parts of the machine. Stoping-drills require oil at least twice a shift; lighter oils than castor, such as Arctic Ammonia, may be used.

Drills used in shaft-sinking can be oiled satisfactorily by placing a good-sized drop-sight lubricator on the station above and connecting it with the air-line supplying the sinking-drills. If this lubricator is properly filled and adjusted, a uniform oiling of the sinking-machines will be effected without the necessity of oiling the drills individually. The grease end should be filled at the station or on the surface before each drilling-period. The shift-boss should see that the machines are greased and also that the lubricators at the station function properly. The life of the air-drill hose is somewhat shortened by this method, as oil attacks the inner tube; but as some oil is always present in the compressed air, this is not a serious objection to the method.

When operating wet drills, the water-valve should always be closed before the air is shut off from the machine so that any water leaking from the water-tube will be exhausted from the machine. After drilling is finished, the machines should not be carelessly thrown aside, but should be carried well back from the face and placed in a clean dry place. Many experienced drill-runners stand the drifting and sinking-machines chuck-end up and pour a liberal quantity of oil into the chuck-end. This prevents rusting if there is moisture in the machine; also, the oil finds it way into the small parts, such as the rotating mechanism.

Stoping-drills are often stood in the opposite manner; that is, with the chuck-end down. Oil is then poured around the air-feed piston, often called the "feed bar." The oil flows down the piston into the air-feed cylinder, keeps the cup leathers soft and pliable and, if the leathers are somewhat worn, passes on into the other parts of the drill.

When machines have been in service for some time without being repaired, they should be sent to the surface to be cleaned and oiled. If this is not practicable, good results can be obtained by pouring 5 or 6 oz. of coal oil into the air hose, connecting it to the machine, and then running the drill for a minute or two. This will usually clean a drill quite thoroughly, but care must be taken to keep all lights away from the face for a few moments for, as the oil breaks up into very fine particles as it is exhausted from the machine, it forms an explosive mixture, which has been known to flash and burn the hands and face of the drill-runner. After the machine has been thus cleaned, the lubricators filled, and several ounces of oil poured in the drill hose, the machine will be found to operate much more freely than before cleaning.

Drill-Shanks. The method of forming drill-shanks on a standard drill-sharpener is simple and quite generally understood. The shanks, however, must be accurately made and maintained at the dimensions specified for the particular steel. A variance of ¼ in. in length will often reduce the drilling speed of the machine 25 per cent. Close attention must also be paid to the shape and location of the hole made to accommodate the water-tube. To avoid excessive breakage of water-tubes, this hole must be 5/16 in. diameter and punched to the depth of at least 3 in. It must be in the center of the steel and, after punching, should be counterpunched slightly to prevent a sharp edge forming that will cut off the water-tube. The shank, of course, should present a smooth striking face.

---

*Abstract of a paper presented at the Lake Superior meeting of the American Institute of Mining and Metallurgical Engineers, Aug. 23-28, 1920.

The shank, when properly formed, is hardened. Sometimes this process is not thoroughly understood. The operation is simple, involves no delicate judgment of temperatures or high mechanical skill, can be learned by any intelligent blacksmith in a few moments, and makes a shank that will not batter, break, or damage the piston hammers of the rock-drills.

The proper treatment of the shank begins in the forging. The steel must not be overheated; that is, it must not approach a white heat. The work of forming the shank should begin as soon as the steel attains a bright red heat. The steel must not be allowed to "soak" in the fire, as this causes scaling; an unduly high air pressure in blowing the forge will also cause the steel to scale, and a scaled shank will not respond properly to the hardening process. After forming, the shanks should be annealed by being cooled gradually; preferably they should be covered with lime or ashes and allowed to cool.

Either fish or linseed oil is satisfactory for hardening, although other light oils are at times used. The quantity required is proportionate to the number of shanks to be hardened at one time; 5 gal. will suffice for the hardening of three or four shanks, but if considerable steel is being worked, 45 or 50 gal. are advisable. A rectangular tank in which the steel can be stood on end conveniently is generally used. A heavy screen should be placed 4 or 5 in. from the bottom in order to hold the steel above any water or dirt that may collect in the bottom of the tank. The oil must be kept free from any foreign matter, particularly water, for water collecting below the oil will over-harden any hot steel that comes into contact with it.

The shank should be heated to a cherry-red at the striking end, with the heat graduated to a dull red just beyond the collars, or lugs; or in the case of the shankless stoping steel, to a point about 4 in. from the end. The shank is then plunged into the oil and allowed to cool thoroughly; the operation is then finished except for testing.

One thing must be borne in mind: each and every shank must be so hardened that it can be readily cut with a file. The shanks must be softer than the piston hammers or damage to both will result. It is obvious that if two pieces of steel of approximately the same hardness are brought violently together, one or both will be damaged. If any piece cannot be readily cut with a file, it should be rejected and re-hardened and the oil tested for water. Care must be taken that too many shanks are not treated at one time, and the oil overheated; if the oil becomes hot, soft shanks will result. The often-used draw-temper water-method requires an extremely fine knowledge of color values, is seldom accurate, and is much slower than the oil method, therefore it should not be used. If the shanks are properly hardened, any well-made piston-hammer will take care of itself.

$300,000,000 for Railroad Improvements. Capital expenditures amounting to nearly $300,000,000 for betterments in 1920 had been authorized or proposed by 122 Class 1 railroads up to July 1, according to information compiled by the Interstate Commerce Commission. This work included the following:

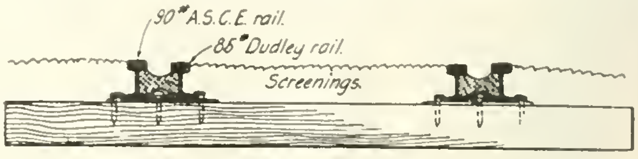
Item.	54 railroads in eastern district	19 railroads in southern district	49 railroads in western district
Additional main tracks	$9,857,669	$1,193,850	$11,661,253
Additional yard tracks and sidings	2,[illegible]	2,791,112	15,140,110
Signals and interlocking plant	3,897,656	316,944	2,553,116
Shops	21,979,135	5,207,055	16,668,918
Station and station facilities	4,377,689	2,245,635	9,725,266
Extensions and branches	2,609,[illegible]	512,322	2,763,916
All other road improvements	62,101,761	17,821,133	77,542,929

An expenditure of $469,847,000 for equipment also was proposed by the above railroads.

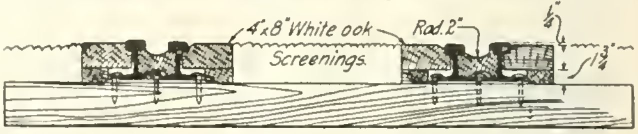
Substitutes for Planked Highway Crossings

In a recent article of some length in the Railway Maintenance Engineer a review is given of the various substitutes for wood in the surface of highway crossings. While it is doubtless a matter of common observation that the planked crossing still predominates, it is claimed that there is an increasing use of the various substitutes, and that this is inevitable in view of the increasing cost and scarcity of lumber.

Committees of the American Railway Engineering Association and the Roadmasters and Maintenance of Way Association have given attention to the matter and have made recommendations as to the desirable qualities such as drainage and elimination of rail joints.



Plankless Crossing.



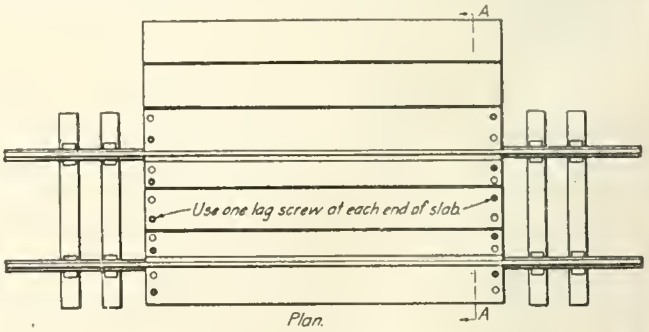
Semi-Plank Crossing

Plankless and Semi-Plankless Crossing on Jersey Central R. R.

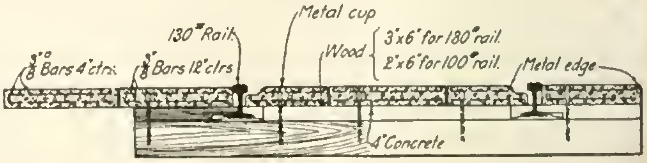
The type of substitutes referred to in the above mentioned article include semi-plank, paving block, concrete, straight macadam, bituminous macadam, and a new commercialized product recently developed for platform and crossing work.

The accompanying illustration and descriptions are reproduced herewith showing the more important of these substitutes.

A plankless crossing has been developed on the Lehigh Valley Ry. which has given very satisfactory results. In constructing this crossing all ballast and dirt is removed down to the bottom of the tie and for the full width of the roadway. Such ties as are not good for at least three years of service are replaced, while tie plates are installed where not already provided. The track is then thoroughly tamped and put in first class condition for line and surface. In automatic signal or electric circuit territory the rail is insulated on all sides by the application of a penetration asphalt or some similar insulating material.



Plan.



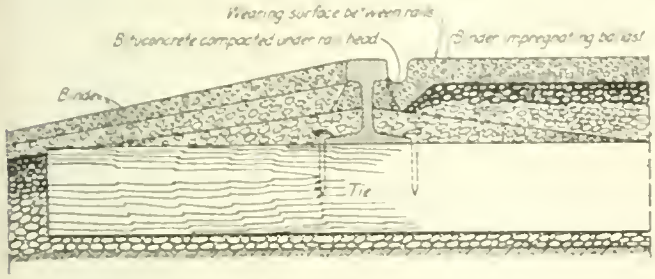
Section AA

Concrete Crossing Used on Pennsylvania R. R.

The space between the ties and between the tracks is next filled up to the under side of the ball of the rail with clean stone ballast, well rammed or compacted. A mixture is then made up of an oil binder and a good grade of clean stone screenings containing particles of stone up to ¼ in. size, but with the fine dust and dirt screened out. The mixture thus made is spread over the surface of the road and thoroughly rolled or tamped to the level of the top of the rail. No provision is made for a flangeway, the action of the wheels along the rails being depended upon to create and maintain their own flangeway, as shown in the photograph. This has proved very satisfactory and at present the Lehigh Valley Ry. has very few planked crossings in service.

One of the recent developments in the line of plankless crossings is a form of construction introduced by the International Bituconcrete Co., New York, which gives a crossing with a good wearing surface and a permanent flangeway, and in addition acts as a seal against the entrance of water to the roadbed. Two classes of material are used in this type of crossing, one a bituminous cement or binder, and the other a prepared and vulcanized mixture of which the crossing surface is built up.

In preparing for an installation of this character all ballast, etc., is removed down to the level of the top of the ties. Rail joints are then eliminated, either by the rearrangement of the rail or by the use of extra long rail, and the track is put in first class condition as regards ties, line and surface. The ballast is then penetrated with the above mentioned bituminous cement or binder, which is applied as a light fluid which hardens under the action of the air to an elastic solid, completely filling the interstices of the ballast. The tops of the ties and the rails are then swept clean of dirt or dust and the sides of the rails, the tops of the ties and the surface of the ballast are thickly coated with the filler. The crossing proper is built up of layers of the surfacing material, separated by thick coats of the filler and carried at least four feet from the rail on the approaches, while the center, or parts between the rails, is built up of a tapering layer of the prepared bituconcrete with ballast on this, after which a top dressing of binder is applied and then about two inches of the surfacing material. This outer material is applied hot and then thoroughly compacted.


Wearing surface between rails
Bituconcrete compacted under rail head
Binder impregnating ballast
Binder
Tie

Section Through a Bituminous Bound Crossing.

The surfacing material is composed of 20 per cent of ⅜ in. to dust trap rock, 20 per cent of denatured hardwood fiber mixed with 30 per cent of impalpable mineral dust colloidally suspended in 30 per cent of 99.1 per cent pure bitumen of normal 50 to 55 penetration. The entire mass is then vulcanized by sulpho-chlorination to form a sort of synthetic rubber. The hardwood fiber denatured by extracting its sap, acids and cellular tissue forms the reinforcement of the surfacing material through its ability to absorb the preservative binder which, after vulcanizing, gives a mass strengthened in a manner not unlike that of reinforced concrete. Being somewhat similar to rubber in its elastic quality this structure is kept "live" by the vibration set up by trains passing over the crossing and thus shows no tendency to break away from the rails.

In recent compressive tests on a 12-in. cylinder 6 in. in diameter the filler of the aggregate was found to have more strength than any other part of the aggregates, the trap rock content breaking in two in each test before separating from the filler, while a sample, measuring 3 ft. long, 8 in. wide, by 2 in. thick, supported at the ends under ordinary room temperature, bent double of its own weight before cracking.

Sand and Gravel Production in 1919.—Approximately 60,-196,000 short tons of sand and gravel of all grades was sold in the United States in 1919, according to preliminary estimates made by L. M. Beach of the United States Geological Survey, Department of the Interior. This quantity represents a decrease below that sold in 1918 of about 1,628,000 tons. The value in 1919, however, was $37,819,000, as compared with $37,927,079 in 1918, which shows that the average price had increased. Producers report that the demand for this material in 1919 was heavy but that the production was curtailed on account of car shortage.

J. G. Leyner, Rock Drilling Pioneer

John George Leyner of Denver, Colo., was [illegible] by an automobile accident near Denver [illegible] an American genius of exceptional ability, a pioneer in rock drilling and mining appliances and an inventor who has contributed much to the industrial progress of his age. No man in fact has done as much in the past generation to advance the art of removing rock. Through his inventions the rock drill has passed from the percussive stage, involving machinery of heavy weights, to the hammer stage, where the rock drill has become a thing but little larger than a pneumatic tool.

To Ingersoll, Joseph Githens and Sergeant belongs the credit for the development of the percussive or piston type of rock drill. During this development, and up to an early period following 1900, engineers considered it impracticable to build a rock drill on any plan other than that involving a rigid and direct connection between the steel carrying the bit and the piston, that is, the drilling bit was an extension of the piston rod. To make a rock drill on this plan and reduce its weight to a point consistent with practical handling in mines and stopes, to simplify it in its mechanism, and to make it stand up against hard usage, were problems that taxed the best energies of inventors between 1870 and 1900. Henry C. Sergeant came to the front and is the recognized leader in the perfection of the piston type of drill.

Mr. Leyner was the first to attack this system. He pointed out what was generally admitted, that the piston type was necessarily heavy, that it was limited in drilling capacity, because of the limit to the number of strokes it could make, and he advocated and patented the use of the piston as a hammer only, to strike the end of the steel or an intervening medium connected with the steel. He introduced a water jet through the piston into the bit for clearing the hole cuttings. His system patent was taken out in 1903 and his method patent in 1904.

Incoporating the Leyner Engineering Works in 1902, Mr. Leyner built shops at Littleton, Colo., soon thereafter. Engaged as he was in pioneer work, developing a new and radical principle in the art of drilling, he encountered many obstacles, mechanical and financial. To build a drill on the Leyner principal required not only superior excellence of design, but the material and workmanship, unless of the highest quality, would naturally result in breakages and excessive wear and tear. For a period of 12 years, in spite of difficulties and successful attacks made upon his drill by the old and leading companies, Leyner stuck to his guns, until in 1911 the Ingersoll-Rand Co. took over all his patents and inventions and transferred the manufacture to their works at Phillipsburg. It has often been said that all that the genius of Leyner required was the experience and mechanical skill of the Ingersoll company to make a success of this new principle. The Jackhamer, which might almost be placed in one's overcoat packet, is built on the Leyner principle. The water Leyner, now known as the Leyner-Ingersoll, is now widely used. It holds the world record for fast tunnel driving.

Leyner's other inventions include the drill sharpener and the Little Tugger hoist used in mines and ship yards. He built the original machines used for producing shredded wheat. His latest invention is the "Linapede" or Leyner Farm Tractor. He was engaged in the development of this tractor at the time of his death.

Mr. Leyner was born in Boulder county, Colorado, in 1860, being the first white child born in that county. He was the son of Mr. and Mrs. Peter A. Leyner. He leaves a widow and three adopted children.

A product of the great West, Leyner was a man of strong physique, a worker with his hands and his head, and stubborn and determined in having his way. It was this faculty which helped him bring his radical idea about the rock drill to the point of fruition. Most men would have given up against such difficulties as he encountered. He was not an easy man to get along with, for he would brook no interference with his authority. Like most inventors his main strength was mechanical, though unlike most inventors his vision was laid on practical lines and in advance of conventional things.

The mining industry owes much to Leyner's genius, the world much to the mining industry. To have reduced the cost of removing rock and ore, as Mr. Leyner has done, is an achievement which should place him at the front among America's great inventors.

Adjustment of Differences Between Labor and Capital*

By HENRY S. SPARKMEN

How can economic peace be restored and industrial unrest banished? I have no definite plan to offer, no specific line of action to suggest. Of one thing, however, I am certain, and that is, that the cure will not be brought about by either the theorizing of the doctrinaire and sentimentalist, whose well intentioned phrasings only serve to excite the passions or befog the reason.

The cure will not be wrought by the zealot or dreamer or by the selfish egotism of either combined labor or capital. If the wealth of the world was a fixed quantity without possibility of increase, and if any gain on the part of labor must be taken from that already in possession of the employer, or vice versa, the antagonism might be explainable.

But, as the wage of both capital and labor is the new wealth created by industry and as neither alone under modern conditions can by themselves produce wealth, the mutuality of interest of labor and capital is evident. The question of the adjustment of differences therefore becomes simply one of proper division of their common product. The difficulty is that we have no formula by which we can estimate even approximately the respective parts labor and capital play in production. To me it seems the development of such an equation is specifically the work for the engineer, who by his professional training is accustomed to careful quantitative analysis of abstract problems, the elimination from consideration of all extraneous and unnecessary elements, the combining together of the fundamental, though often opposing forces, into a stable one. It would be a crowning glory to our common profession if we could out of the chaotic and disturbing conditions of today so reconstitute industry that it would be controlled by all in the common interest, the distribution of the wealth produced being based on principles of equity and reason mutually agreed upon.

Has Labor Received Just Compensation?—In the working out of such a system greater weight must be given to the capital cost of labor than heretofore. Let me demonstrate:

Assume that slavery still exists, that we are a gathering of business men who propose to spend $1,000,000 in the construction of a new manufacturing plant which would require the services of 500 men in its operation, and are debating whether it will be cheaper to buy slaves at $1,000 each, or employ free labor at 50 ct. per hour for an 8-hour day. The capital investment would be $3,000,000 instead of $1,000,000, and securities representing capital invested in labor would control the corporation and receive two-thirds of the profit and the cost per man per day would figure something as follows:

To 6% interest on $4,000, average cost of a man	$ 240.00
To depreciation due to absolescence through age 3%	120.00
To insurance on life	100.00
To reserve fund for maintenance during decrepitude of old age	100.00
To food and housing and $5.00 a week	260.00
To clothing, including laundry, barber, etc.	100.00
To medical and dental attention, etc.	75.00
	$ 995.00
To profit on investment of $4,000 @ 10%	400.00
	$1,395.00

Divide this by an average of 250 working days per year, gives $5.50 per day in round numbers, and in this calculation no account has been taken of the maintenance of children, taxes and other expenses, as the profit from the sale of the children would supposedly cover this expense.

Granted that this calculation only proves what economists have demonstrated for years, that slave labor is the dearest of all forms of labor, does it not, however, suggest that perhaps we have been paying free labor too little?

---

*From an address May 11 before Engineers' Club of Philadelphia.

Greater Application of Recommended Practice to Individual Railroads*

By C. A. MORSE.

The American Railway Engineering Association has spent 21 years in the study of the maintenance methods and practices on the different railroads of the United States and Canada, and its committees have been composed of representatives of these railroads who have been actually engaged in maintenance of way.

The practices, methods and appliances in use on different railroads have been tabulated, and studies made of the results obtained; from these studies they have reported recommended practice. These recommendations have been reviewed and amended from time to time, until at this time there is no question about their being the very best authority as to what will give the most economical and safe construction and maintenance of the railroads of the American Continent.

With the passage of the Esch-Cummins Transportation Act, the Interstate Commerce Commission is instructed to make such rates as will, in addition to paying operating and maintenance expenses, and a proper depreciation, return a certain rate of interest on the investment in the railroads as a whole, or in certain groups.

It is evident that in order to be fair to all railroads and to the patrons of the railroads, there should be a classification made of the different roads and sections of the same road, based upon density of traffic, weight of locomotives and frequency and speed of passenger trains, and there should be a specification covering construction and maintenance of each class of road to be followed by all the railroads in that group, so that the money expended by the different roads shall be fairly uniform, in order that the receipts from the established rates shall not be too lavishly expended in one case or too niggardly expended in other cases.

There are no records or recommendations that will permit of this that are based on such general study and careful consideration as those of the American Railway Engineering Association, and it is fair to presume that their recommended practice will be adopted.

There is a strong probability that a stop will be put to the present practice whereby over 50 different sections of rail are rolled between the weights of 70 lb. and 140 lb. per yard, when seven sections will answer all the purposes, and are all that are recommended by this association.

A set of rail rolls costs about $5,000, and a rolling mill has to carry an investment of $250,000 for rolls to roll 50 sections, when they would have to carry an investment of but $35,000 to be prepared to roll but seven sections. The railroads, and through them the public, have to pay the interest on this additional $215,000 invested by each mill in surplus rail rolls.

The same thing applies to rail joints and tie plates. The public is not going to continue to pay increased railroad rates to meet the whims of individual railroads.

One of the practices that has the least reason for existence and which costs an immense amount of money per year is that of the variation in punching or drilling of rail. There is absolutely no reason why all rail of the same section should not be drilled the same. With this standardized, all joints for that section of rail would be drilled the same.

Frogs and switches should be the same for the same class of railroads, thus doing away with the innumerable patterns that frog switch manufacturers have to carry today, and permitting the manufacture of frogs and switches for stock instead of having to make them to order, as is the present practice.

There should be uniformity in width of roadbed, width of cuts at subgrade, depth of ballast, amount of shoulder for ballast of different kinds; also in the use of treated track, bridge and switch ties, and the use of tie plates. Many roads in the past who have recognized the economy of treated ties, and the use of tie plates, have not used them on account of immediate expense.

---

*From the July Bulletin of the American Railway Engineering Association.

The new conditions are going to call for the practice that is the most economical in the long run, as the public will have to pay the bills in rates and they are entitled to have these rates as low as the best practice and the practice that is most economical in the long run will produce.

There has been much "penny-wise and pound-foolish" practice in maintenance of way and structures in the past, due to the inability of the individual railroad to get the money with which to do the most economical work.

Under the Transportation Act the Interstate Commerce Commission will have a revolving fund which can be loaned to the railroads, that cannot otherwise get the money, so that their methods will be such as will give the greatest ultimate economy.

It is to be hoped that the reorganized American Railroad Association will be used by the Interstate Commerce Commission as the medium through which uniformity of practice can be secured, and that the American Railroad Association will be given mandatory powers to enable it to secure these results.

Section II—Engineering, of the American Railroad Association, consists of the American Railway Engineering Association; the former Signal Association and former Committee on Electrical Working, and is the Section that would be called upon for recommendations as regards Maintenance of Way and Structures.

The American Railway Engineering Association is particularly well qualified in view of its 21 years of study of maintenance problems to function promptly and efficiently in this capacity.

Rate Increase Brings Inadequate Relief to Railways

The rate increase granted July 31 by the Interstate Commerce Commission affords a palliative, but will not cure the net income ills that for more than a decade have afflicted the railways, states Slason Thompson in a "Bulletin of Railway News and Statistics." Mr. Thompson gives the following figures to bear out his contention:

To begin with, the commission puts an arbitrary value of $18,900,000,000 on the railways where the reports on file in its office show a book value of over $21,000,000,000 as long ago as 1917. Even on this undervaluation the Cummins-Esch law calls for a net operating income of $1,134,000,000.

For the first four months of 1920, excluding $50,000,000 back mail pay in January, the railways showed a net operating deficit of $13,000,000. May and June should wipe out this deficit and, sans the rate advance, revenues should exceed the expenses for the year by aproximately $100,000,000.

But the revenues for April, 1920, were running only 3 per cent ahead of those for April, 1919, whereas the expenses had jumped 18 per cent. If this percentage of increase in expense is maintained for the twelvemonth, the total for the year will be in the neighborhood of $5,210,000,000.

Figuring on the complete year with the Railroad Labor award included for eight months and the rate advance for four months, here is about how the railway account for 1920 will stand:

Operating revenue as indicated	$5,400,000,000
Plus rate advance for four months	500,000,000
Total	$5,900,000,000
Operating expenses as indicated	$5,215,000,000
Taxes	250,000,000
Equipment and facilities rents	50,000,000
Wage award	416,000,000
Total	$5,931,000,000
Deficit	31,000,000

Thus it appears that so far as 1920 is concerned the rate advance will not much more than take care of the Labor Board award, leaving the $600,000,000 guarantee by the Government to pay about 3 per cent on the commission's valuation of the railways.

For 1921, with revenues and expenses running neck and neck as in 1920, here is how the situation works out:

Operating revenues	$5,500,000,000
Plus rate advance	1,500,000,000
Total	$7,000,000,000
Operating expenses	$5,300,000,000
Taxes	260,000,000
Equipment and facilities rents	50,000,000
Wage award	625,000,000
Total	$6,235,000,000
Net operating income	765,000,000
Short of 6% on $18,900,000,000	369,000,000

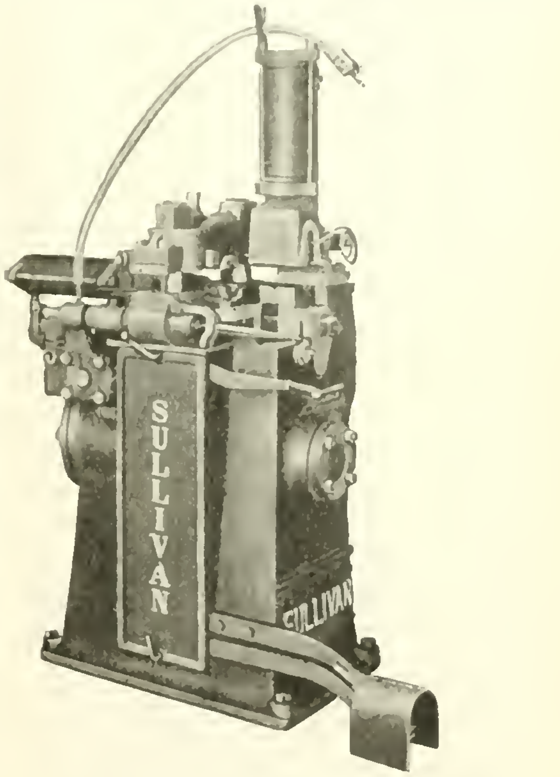
It is therefore evident that the rate advance granted by the commission will come approximately a third of a billion short of the requirements of the Cummins-Esch Act.

It must be remembered that these estimates are based on conditions as they are and not on conditions as to traffic, labor and cost of materials as they may develop. Higher rates and fares may put a brake on traffic and travel, so that the gross revenues will not increase relatively.

A Hammer Sharpener for Hammer Drill Steel

A new model of the Sullivan drill sharpening machine, embodying the same principles as the older sharpener, but of smaller and lighter construction, has been brought out by the Sullivan Machinery Co., Chicago.

This machine, which is shown in the accompanying illustration, is known as the Sullivan Class "B" Sharpener, and is designed for handling solid or hollow steel of any section up to 1¼ in. in diameter, and to make bits up to a maximum gage of 2½ in. The Class "B" Sharpener weighs 1,500 lb., as compared with 4,000 lb. for the larger machine; occupies a floor area of 4 by 2¼ ft., and stands 5 ft. high.



Sullivan "B" Drill Sharpener.

The essential features of the sharpener consist of a horizontal hammer cylinder and piston, operating a dolly for upsetting, and a vertical cylinder and piston operating dies for swaging the drill bits or shanks. For upsetting, the steel is clamped in steel dies mounted in the lower, or stationary, and upper, or movable jaws of a yoke or vise operated by a horizontal air cylinder situated in the base of the machine.

The vise, or clamping cylinder and piston, are of the differential type, the closing or clamping end being 10 in. in diameter, and the releasing end 4 in. in diameter. The action of the vise is controlled by a valve placed in a valve chest on the side of the frame, and operated by a hand lever from the front of the machine. A safety stop is provided, which makes it impossible for the upsetting hammer to start until the steel is securely gripped by the vise. The two-hammer cylinders are modified Sullivan "DR-6" drills, equipped with floating hammer pistons, and a valve motion which imparts a blow of great strength and liveliness to the dies and dollies. Air is admitted to the horizontal hammers by the same valve mechanism which controls the vise.

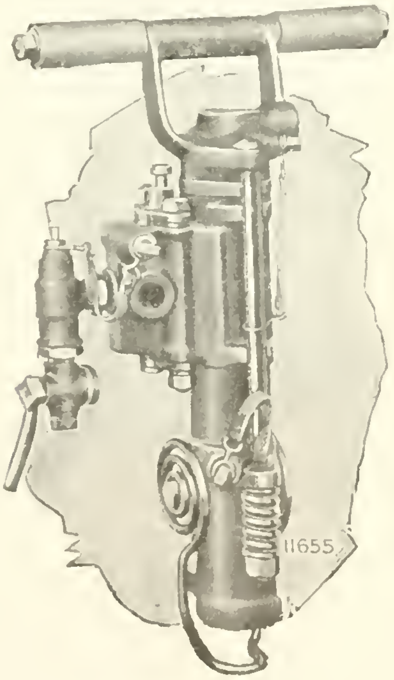
In order to secure the advantages of the floating hammer piston in the vertical member of the sharpener, a novel construction has been employed. When air is admitted to the vertical hammer cylinder, the pressure acts on top of an annular piston fitted in the lower cylinder head, which forces the upper, vertical swaging die down against the steel and holds it in this position in the same manner as the hand blacksmith, or his assistant, holds the flatter or swage in hand-forging work. The vertical hammer then strikes against the die, drawing out the corners of the steel to proper gage and thickness, with a high degree of precision, and the same effectiveness as is the case with the older, model "A" Sharpener.

For cleaning hollow drill steel an automatic blow gun or jet is provided in the front end of the frame, below and to the left of the vertical hammer. At this point a small nozzle will be noted, against which the hollow steel may be thrust, thus opening the valve, and permitting air to be blown through the steel. Exhaust air is also used for automatic cleaning jets in an ingenious manner from both the horizontal and vertical hammers, so that the working faces of the dies and dollies are kept clean and free from scale and accumulations of dirt and dust at all times.

The Sullivan "B" Sharpener, light model, is operated by compressed air at a recommended pressure of 80 to 100 lb.

Another New "Jackhamer"

Another "Jackhamer" has just been brought out by the Ingersoll-Rand Co., 11 Broadway, New York. It is known as the "DCR-13." This completes the "family of Jackhamers" manufactured by this company. The others are: the "BAR-33," 21 lb.; the "BBR-13," 36 lbs.; the "BCR-430," 41 lb., and the "DDR-13," 70 lb ; altogether there are five sizes and 13 types. This company now claims to have a "Jackhamer" available for every hand hammer rock drilling job.



"D C R-13" Jackhamer.

The new "Jackhamer" weighs 55 lb. It is rated to drill holes up to 12 ft. deep rapidly in hard rock and it is claimed it will fill all the requirements of a medium weight "sinker" or down hole drill.

The features most worthy of note are.

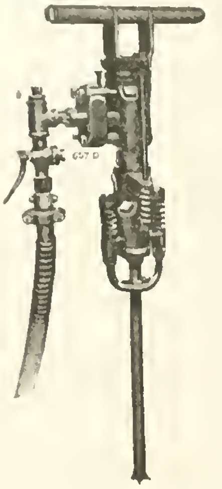
All Steel Construction. Steel drop forgings or bar stock being used exclusively and specially heat treated.

All Bolted Construction Nothing to work loose and easy of access. Automatic Rotation—Very powerful, relieving the operator of this fatiguing part of the work. Spring Retained Front-Head—Takes up shocks that would otherwise fall on the machine. "Spool Butterfly" Valve Operating on the well known "Butterfly" principle. "Handy" Hole Blowing Device—Very effective in keeping the drill hole clear. Renewable bushing in rotation sleeve. Automatic "Heartbeat" Oiler and grease pockets in handle and fronthead assure continuous satisfactory lubrication.

These drills are furnished for drilling dry holes (DCR-13) and wet holes (DCR W-13). Although they are usually used unmounted as sinkers, they may also be supplied with the "JC-11" Mounting for development or light drifting work.

New Light Rock Drill

The Denver Rock Drill Manufacturing Co., Denver, Colo., has recently developed a new type of light mining and quarrying drill. This new type of drill is built in three models, known respectively as Models NA-90, NRW-93 and NRD-95; the first named being a "dry" auger drill, especially designed for work in coal, iron and other soft formations; the second, a combination "wet" and "dry" rock drill for all kinds of rock and all conditions, either above or below ground; and the last named, a "dry" rock drill for work in wet shafts or where out-of-door conditions prevail. All three drills are extremely light so that they can be easily carried about, and each is operated by one man alone. They are built throughout of the very best steel compounded and with the utmost precision. While most Waugh drills are of the valveless type, the "Nineties" are equipped with an entirely new type of spool valve, having a positive action. The rotation mechanism is of exceptionally strong design in which stresses in both teeth and pawls are reduced to a minimum. Lubrication is effected by pulsations of air which gradually feed the oil from a reservoir at the side of the cylinder into all parts of the machine.



New Ninety Drill.

Personals

D. R. Campbell, for several years general superintendent of the Pacific division of the Canadian National Ry, has been transferred to Winnipeg, where he will have charge of construction in the west.

Colonel Spencer Cosby, corps of engineers, United States Army, has been appointed division engineer for the southeastern division, relieving Colonel William J. Barden, acting division engineer, who goes to Cincinnati.

H. C. Dixon, chief engineer of the Government Railways of Canada, has announced the following appointments: J. A Heaman, assistant chief engineer; J. G. Legrand, bridge engineer; William Burns, engineer of construction; William Walkden, assistant bridge engineer; J Schofield, architect; J. E. Davison, assistant to chief engineer; H. P. Blake, engineer of water supply.

J. L. Longino on Sept. 1 became manager of the Pine Bluff Co., Pine Bluff Ark., operators of street railway, electric light and water properties. He succeeds J. A. Whitlow, who becomes traffic manager of the Arkansas Light & Power Co. The duties of operating superintendent of the Arkansas Light & Power Co., which have been handled by Mr. Whitlow, will be assumed by F. M. Wilkes. Mr. Longino has been superintendent of the Arkansas Light & Power Co. properties, and Mr. Wilkes commercial manager. These are the only changes in the operating personnel of the companies. The other officials are: Arkansas Light & Power Co., L. Garrett, assistant to the president; William Crooks, chief engineer; W. E. Baker, auditor. The Pine Bluff Company: L. B. West, auditor; M. M. Bridgwater, asisstant to manager and load dispatcher; Parker Tucker, commercial manager.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Wagon Loaders.—George Haiss Manufacturing Co., Inc., New York. 8 page booklet illustrating and describing operation of the Haiss "Path Digging" wagon loaders.

Core Drilling.—Sullivan Machinery Co., Chicago, Ill. 32 page booklet describing core drilling with Sullivan diamond core drills. Contains numerous illustrations and much useful information on this class of work.

Rock Drills.—Sullivan Machinery Co., Chicago, Ill. 4 page bulletin describing the new model Sullivan "Plug" drill for granite quarries, and a 28 page bulletin illustrating and describing the Sullivan rotator drill.

Steam Shovels.—Ball Engine Co., Erie, Pa. 24 page bulletin containing a general description of Type B Erie Shovel. Contains numerous illustrations, both half tones and line cuts, and text explaining the uses of this shovel for various kinds of excavating.

Excavating Machinery.—Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.—Circular entitled "Electrification of Excavating Shovels," which describes and illustrates the various uses to which electric shovels may be put, such as railway work, coal mining and dragline excavating. Tables are included showing the approximate energy consumption of electric shovels and dragline excavators.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., SEPTEMBER 22, 1920. Number 12.

When Will Bond Interest Rates Fall?

Not a little public work is being held up because bond interest rates are regarded as being abnormally high. We wonder how many people know that interest rates on bonds sold at par rose for eight years after our Civil War ended, although they were very high in 1865? In "A Century of Prices," by Burton and Selden, there are several charts showing "bond yields" and commercial paper interest rates for every year since 1860. Corporation bond yields ranged from 5.9 to 7 per cent in 1865, and from 7.2 to 8.1 per cent in 1873, the rise having been quite uniform during those years. Following the panic of 1873 came a fall in bond yields, but the fall was relatively slow, the low point being reached in 1901 when bond yields were 3.7 to 3.8 per cent.

It is noteworthy that bond yields have moved in sympathy with commodity prices, generally following the latter with a lag of two to eight years.

This being so, it is probable that bond yields will continue to rise for several years. Therefore it will be futile to postpone public works in the hope that bonds can be marketed at higher prices than they now bring.

The main reason why bond yields vary with commodity prices has never been correctly given, we think. It is this: As commodity prices rise or fall, the market value of fixed property (buildings, plant, etc.), rises or falls. The owners of bonds or other mortgages seek to share in the gain that occurs when property values rise, and they begin to sell their bonds or mortgages and buy deeds or stocks. This depresses the price of bonds or mortgages, which is equivalent to increasing their "yield." The converse happens when commodity prices fall, for then it pays to sell stocks and buy bonds.

In addition to this phenomenon there is another during and following a war, namely, the issuance of large amounts of government bonds, which serves to depress the price of all bonds by increasing the supply offered for sale. Following the close of a war, corporations undertake to float bond and notes that were deferred during the war, and thus prolong the period of high interest rates.

The world war not only caused our government to issue more than 20 billion dollars worth of bonds, but led foreign governments to float loans in America. Foreign governments owe the American government nine billion dollars, which they will try to take up by the sale of bonds to the American people. France has just sold at par in America $100,000,000 of 8 per cent bonds. This is probably a forerunner of many another similar sale of foreign bonds. The inevitable result will be to depress the price of all bonds: that is, to raise the interest rate of bonds marketed at par.

The following table shows what has happened to bond yields since 1903.

Year.	1903	1910.	1920.
Municipals	3.31	4.00	5.07
Rails	4.10	4.21	6.88
Utilities .	4.63	4.79	7.51
Industrials	5.69	5.25	7.56

The above percentages are averages for each of the three years, as given in the September letter of the National City Bank of New York.

The yield of British consuls has followed the curve of British commodity prices for the last 130 years, and with such remarkable coincidence that there can be no doubt as to the correctness of the explanation above given as to the cause of bond yield changes.

As typical of much of the false economic reasoning that is current we quote the following from an editorial article in The Iron Age of Aug. 5:

> Apart from the deterrent of building costs being high, there is the influence that interest rates are high. A period of overconstruction is always marked by low interest rates according to those who hold to the doctrine that an excess of permanent construction brings about an industrial depression. Lately there has been a coterie arguing that interest rates are not high on account of alleged "new conditions," but that as everything else has gone up, so interest rates must advance also. By this reasoning the present interest rates might be held to be low compared with what is coming. There is a fundamental fallacy in that whole argument about interest

rates, however, the fallacy being that rates per cent are compared with commodity prices and wage rates expressed in dollars. The things are not comparable.

Had the writer of the article just quoted taken the pains to study the curves of commodity index prices and of bond yield rates he would never have said, "The things are not comparable." He would have seen that the two curves move up and down in a harmony that makes it certain that commodity prices and bond interest rates are functionally related.

It is unfortunate that so many editorial expressions of opinion on economic matters are coming from editors who do not take the time to study the available data that would show whether their opinions are true or erroneous.

The Engineer and the Painter vs. the Architect

Wyndham Lewis, the British artist, recently criticized the modern architect very severely and somewhat unjustly. Nevertheless, there is food for thought in at least a part of his utterances, as, for example:

> The painter and the engineer could buy him (the architect) out, going into partnership, and produce what would be neither a world of boxes on the one hand, as it would be if the engineer controlled house construction, nor of silly antique fakes on the other, as happens when the architect has his sweet and horrible way. . . .
>
> Let us banish absolutely the stylistic architectural rubbish. But even as to the shaping of the box or series of boxes let the artist be used. . . .
>
> We hear a great deal of rubbish talked about the skyscraper. The skyscraper, for the most part, is a tall box. So far it has been nothing but that; except where, as in the Schiller Theater Bldg. in Chicago, and the famous Woolworth buildings some dreadful intervention of art has converted it into an acre-high advertisement of the modern architect's fatuity.
>
> It has been a fashion lately to admire the skyscraper in its purely engineering forms, and other forms of quite plain engineering construction. But a box is always a box, however high. And when you think of the things that could have been done by a liaison of the artist's fancy, once more, with all those works of engineering genius, you wonder that there is not one single example which one can quote of such a structure.

Mr. Lewis is not very definite in pointing out how much of a part the "painter" should play in his suggested association with the structural engineer, but the following quotation indicates that the "painter" should do more than decorate the surface of the building with suitable color.

> If you say that the design and ornament over the body of the building is the same as the clothes on a man's back, there is still something to be said about the naked shape of the man or even for his skeleton The nature of the body or of the skeleton will decide what the character of the clothes must be So the artist should come in long before he usually does, or give a new consciousness to the shaping of the skeleton of the engineer. This should be invariable, not occasional: that is, when the first painters or sculptors have been used for this purpose, instead of the horrible stock architect.

The question naturally arises as to a "painter's" ability to "shape the skeleton" more artistically than it is ordinarily shaped by an architect Would not a "painter" capable of artistic design of the "skeleton" be in reality less a painter and more an architect? Is not Mr. Lewis vainly striving to make the terms "painter" and "artist" synonymous?

It seems to us that what Mr. Lewis is really attacking is not the architect in general but the imitative and conventional architect. Such an attack may with equal force be directed against the average artist, whatever his class, whether painter, musical composer, sculptor or architect; and the following picture will therefore be quite as true of the average "art man" of one class as of another.

> He gushes about everything he sees. He is enraptured at the curious clumsy country print found on the lodging house wall, at the beauty of cheap china ornaments, a stupid chair, a staring mean, pretentious little sea-side house. When with anybody, he will titter or blink or faintly giggle when his attention is drawn to such a winning and lovely object. I am, you will perceive, drawing a picture of the English variety of art man The most frequently used epithet will be "jolly" for the beautiful; and the pursuit will invariably be described as "fun" So we have before us, all said and done, a very playful fellow indeed, who quite enters the spirit of this "amusing" life, and who is as true a "sportsman" as any red-coated squire; only for the pursuit of "jolly" little objects like stuffed birds, apples or plates, areas of decayed wallpaper, and the form of game that he wishes rather smirkingly and naughtily to devour, he must be as cunning, languid, and untidy as his distinguished fellow-sportsman is alert, hearty, and colored like a letter-box.
>
> For stalking a stuffed bird you have, in the first place, to be a little bit dead yourself.

Specialization in Engineering

The definite profession of the engineer is of comparatively recent origin. There have, of course, always been men under whose eyes the work of the world has been done. The Roman highways, the bridge of boats that gave the Persian access to Europe, the pyramids, the great works of the Mesopotamian plain—all these called for what we recognize as engineering instincts and abilities in the conception, the planning and the execution. Even the early arts, like bow-making and pottery and boat construction, are examples of primitive engineering skill—the making of anything that comes out as it was intended to come out and that serves the purpose for which it was planned is engineering work. But throughout the prehistoric, ancient and medieval periods and well into the modern, the engineer was merely the boss artisan.

With the widening of human knowledge since, say, 1800, the effort to keep this corpus in order and to apply it to concrete cases as they arise has demanded a special profession. To meet this demand the engineer was created—or created himself; and he has been in existence long enough for us to get something of the historical viewpoint toward him. Various aspects of this viewpoint might be emphasized; the one that inspires these remarks has to do with the manner in which the vast field of the engineer was, and the manner in which it now is, subdivided. There has been here a significant shifting of lines.

Originally we had the civil and the mechanical and the electrical engineer. From the day when the engineer was first called on for evidence of specialization within his field, he followed one of these three directions. The first-named would apply his knowledge with equal facility to the laying out of a railroad or the surveying of a new country or the erection of a great bridge or the designing of a floor to carry a heavy load or the throwing of a dam across a stream or the location of the best highway between two given points. The second found it a matter of indifference what sort of a factory he was sent to, or what manner of machinery he was asked to install or maintain there. And the last-named was quite prepared to work in telegraphy today, in dynamos tomorrow, in street car motors or trolley wires the next day, and in electrolysis next week. The engineering field was divided according to the raw materials of the engineer, and, so divided, it fell naturally into the three domains outlined—that of the engineer whose raw material is electricity, that of the one who does things with machines, and that of him who works with the static forces of the visible external world.

In the beginning of the profession this was altogether satisfactory. It has not remained so. The first sign of a break in the old scheme came early, with the segregation of the mining engineer as a distinct sort of animal. To qualify for this profession a man had to have some of the equipment of each of the three pre-existing groups, but in none of these fields did he require complete training. The reason for building up this composite of the three existing branches and giving it a name and a standing of its own was the very excellent one that mining work called for all three types of service, yet made demands which it seemed should be possible for one man to meet. So the man arose to meet them, embodying in his own equipment the elements of the necessary co-operation between civil, electrical and mechanical engineering, making his own such parts of these three fields as he needed in his business and discarding the rest.

Eventually the process was repeated, not in one but in many instances. What it then came to was the regrouping of the engineers on a new basis. It would mean nothing today to claim to be a civil or a mechanical or an electrical engineer—it would give not the least information as to what the claimant was qualified for and what he was not. For today we have railroad-signal engineers and automotive engineers and safety engineers and marine engineers and turbine engineers and dock engineers and conveyor-belt engineers and magneto engineers and highway engineers and subway engineers and a host of others which we have neither the time nor the space nor the patience to catalog. Each of these professions is distinguished from the others, not so much in what the incumbent has by way of technical equipment as in what he does with it. So the old division on a basis of raw materials has passed away and today we catalog our engineers according to their finished products.

This is eminently sensible and essentially modern in viewpoint. Three thousand years ago it was natural and proper to group workers according to the material in which they worked. In those simple days a man was a mason or a carpenter or a weaver or an ironsmith or a coppersmith or silver-and-goldsmith. At that date it would have been ridiculous to group the mason and the tent maker together on the mere ground that both were engaged in the construction of human habitations. But with the multiplication of tools and of knowledge it would be just as absurd to catalog a manufacturer of telephone wire and a photo-engraver in the same group on the mere ground that they both use copper as a raw material. We prefer to regard the wire maker as an industrial brother of the battery builder and the man who makes composition stands and mouthpieces, while we relate the photo-engraver and with the compositor and the pressman—substituting a classification that follows the finished product for the one that follows the raw materials employed. So it is in the engineering field, and properly. Civilization weaves so complex a web of causes that we find it far easier to distinguish and identify results.—Editorial in Scientific American.

Lengthen the Construction Season

Engineers and architects are noted for finding ways and means to produce structures in the face of obstacles which often seem impossible to overcome. Such problems invite inventive genius and challenge skill. Their successful solution attracts public attention and compels admiration because they are unusual, but in a majority of cases the ways and means devised are of value only as representing a solution of a special problem.

There are aspects of construction such as standardization and winter work which, though not unusual, contain in a larger measure the elements of permanent advancement in processes and customs relating to construction than does the solution of special problems. However, the very lack of the unusual is to a large extent responsible for slow development in the way of standardization and the adoption of simple means for construction throughout the year which would be of great value to the construction industry as a whole.

Only a few years ago engineers and contractors looked at the coming of cold weather as marking the end of active construction and except for the necessity in point of early use, which was enormously intensified by war-time requirements or the fact that a contractor was caught with a penalty clause in his contract, the advent of freezing weather would still mark the end of building activities.

Throughout last winter the pressing necessity for more buildings brought about an unprecedented continuation of construction. Concrete buildings were in process of erection all over the country throughout the entire period of cold weather and this activity stopped only when exceedingly unsatisfactory transportation conditions made it impossible to get necessary materials on the job.

The important lesson to be derived from this experience, which as usual was the result of necessity forcing the accomplishment of something which had hitherto been tacitly accepted as practically impossible, is that construction may proceed throughout 12 months regardless of temperatures and weather conditions and that too without adding greatly to the cost. In fact, it has been well demonstrated that if a building project is decided upon in the early winter it is usually more profitable to go ahead with its construction during the winter months and obtain early occupancy than to put off construction until spring. In other words, if the building is completed during the winter months it will be ready for occupancy as soon as construction would be started if delayed until spring. The value of early occupancy thus more than offsets any additional cost caused by winter construction.

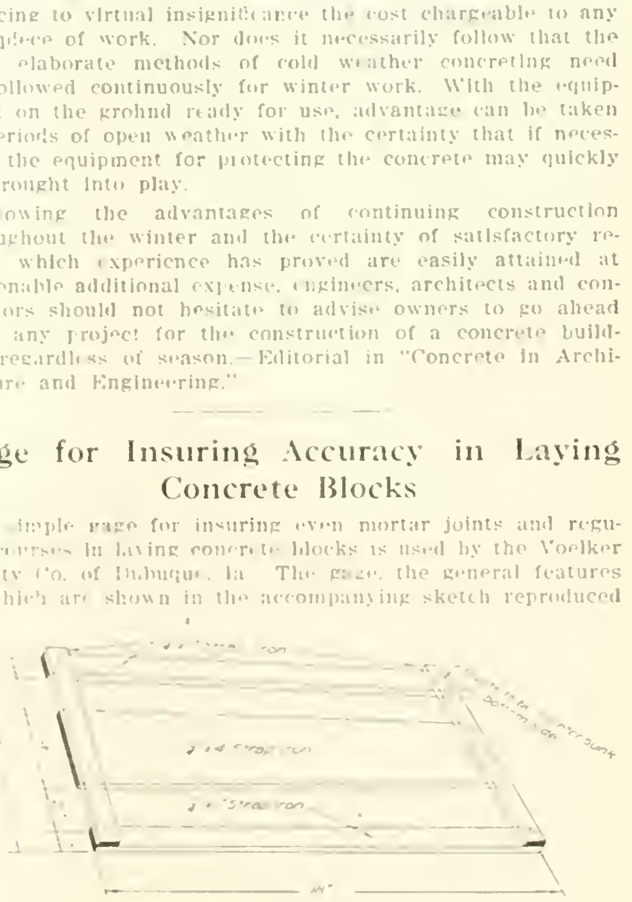
There are several other important advantages that would accrue to a continuation of construction throughout the year. Construction organizations can be held together and thereby the average total efficiency made much higher for the entire 12 months than for the few months of the so-called construction season. The overhead cost of construction such as depreciation and interest on investment in equipment is also reduced proportionately. Labor engaged in construction is favorably affected by the steady employment afforded. Production and transportation of construction material subject to seasonal demand would proceed with the advantage of more uniform quantity and thus allow planning for the future. Moreover, if the transportation of construction material which with seasonal demand must necessarily be seasonal, were more evenly distributed, the peak load would be cut down and the total of transportation equipment and facilities required to handle seasonal demand would be reduced.

In view of these important advantages it is worth while to inquire in regard to the disadvantages. Visions of frozen piles of aggregate, frozen concrete and loss to the contractor through failure of his work to pass inspection because of the effect of freezing, may lead not only the contractor but the owner to wait until temperate weather is assured before going ahead. Past experience amply proves these fears unfounded. True there is some added expense required for heating the materials for cold weather concreting, including protection such as the use of tarpaulins and other means to enclose the structure, together with supply artificial heat by means of salamanders or steam pipes. The equipment required to carry on cold weather concreting is not expensive and after familiarity acquired through use the percentage of additional expense per unit of finished structure is exceedingly small. The equipment can be used many times so that the oiginal cost is spread over a number of jobs, thus reducing to virtual insignificance the cost chargeable to any one piece of work. Nor does it necessarily follow that the most elaborate methods of cold weather concreting need be followed continuously for winter work. With the equipment on the grohnd ready for use, advantage can be taken of periods of open weather with the certainty that if necessary the equipment for protecting the concrete may quickly be brought into play.

Knowing the advantages of continuing construction throughout the winter and the certainty of satisfactory results which experience has proved are easily attained at reasonable additional expense, engineers, architects and contractors should not hesitate to advise owners to go ahead with any project for the construction of a concrete building regardless of season.—Editorial in "Concrete in Architecture and Engineering."

Gage for Insuring Accuracy in Laying Concrete Blocks

A simple gage for insuring even mortar joints and regular courses in laying concrete blocks is used by the Voelker Realty Co. of Dubuque, Ia. The gage, the general features of which are shown in the accompanying sketch reproduced from The Concrete Builder, consists of three pieces of iron ¼ in thick riveted together with sticks across the ends. The gage is laid on the block, the closed portion in the center covering the opening in the block. Mortar is then spread in the open spaces and struck off even with the top of the gage. This leaves an equal thickness of mortar at all points and insures straight, even mortar joints and regular block courses.



Gage for Concrete Block Laying.

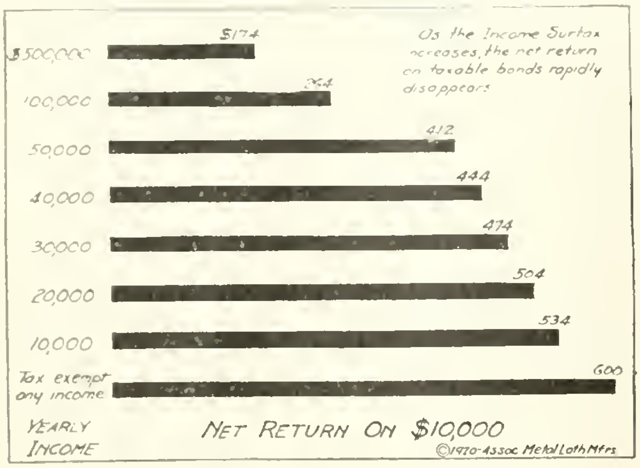
Why Everyone Should Advocate Mortgage Tax Exemption

By WHARTON CLAY,

Commissioner, Associated Metal Lath Manufacturers

The construction industry has been worried about the transportation situation, but the minute that the banks were unwilling to float loans, building activities stopped and railroad conditions and coal became only incidental.

The banks were obliged to stop construction loans, not because of prices of materials, but because they could not dispose of the real estate mortgages to their customers. This was largely due to the Federal income tax which, with its heavy surtax on the larger incomes, makes mortgage buying at 6 per cent absolutely impossible. Exactly how this works against the larger incomes—the sources of most of the investment money—is seen below.



Net Return on $10,000 for Various Incomes.

The present agitation to make mortgages on homes exempt from Federal tax should, therefore, be thoroughly understood by those who are in the building business, and who are now powerless to aid in the housing shortage, because loans are not available.

No one factor is as vital to the safety of the whole country as the building of homes, and it is, therefore, the privilege as well as the duty of everyone connected with the building industry who understands this situation and whose very livelihood depends upon construction activity, to advocate legislation which will release vast sums for home-building.

The Government—that means the people—have within their reach a very powerful force to attract sufficient capital to the construction of homes if it is only called into play. To encourage American manufacture, a tariff was imposed, and to increase farm loans and municipal improvements, exemption from Federal income tax was inaugurated.

No one can blame the man with an annual income of $50,000 for refusing to make investments that will yield but $412 on $10,000 when he can get $600. It is good business for rich man or poor, to make the investment that looks most profitable, so a unified appeal to every member in Congress for the tax exemption of mortgages, is now the only logical solution.

The bulk of new money for mortgages must come from estates and individuals having such excess funds as are not available until incomes of $20,000 or over are reached. As an example an income of $30,000 is subject to a Federal normal and surtax, totalling 21 per cent in addition to the income taxes levied by several of the States. This income tax must de deducted from the gross return on the mortgage before the net return to the investor is found.

To compete with the 6 per cent municipal bond which is exempt from income tax, the banks cannot offer a $30,000 annual income investor anything less than 7.6 per cent on a taxable mortgage, or to the $50,000 annual income investor anything less than 8.7 per cent and have him come out even. With mortgage tax exempt, however, they could readily be sold at a 5 per cent and 6 per cent basis.

Already the State of New York has removed the State income tax from mortgages up to $40,000. It is up to Congress to remove the Federal income tax. All people must understand the situation, because Congress responds only to popular demand.

If each reader would print on his letter-head the slogan "Exempt New Home Mortgages from Income Tax" and would explain to his friends and his local newspaper editors the reasons behind the movement, the tax would be removed, and the housing shortage would be relieved in less than two years.

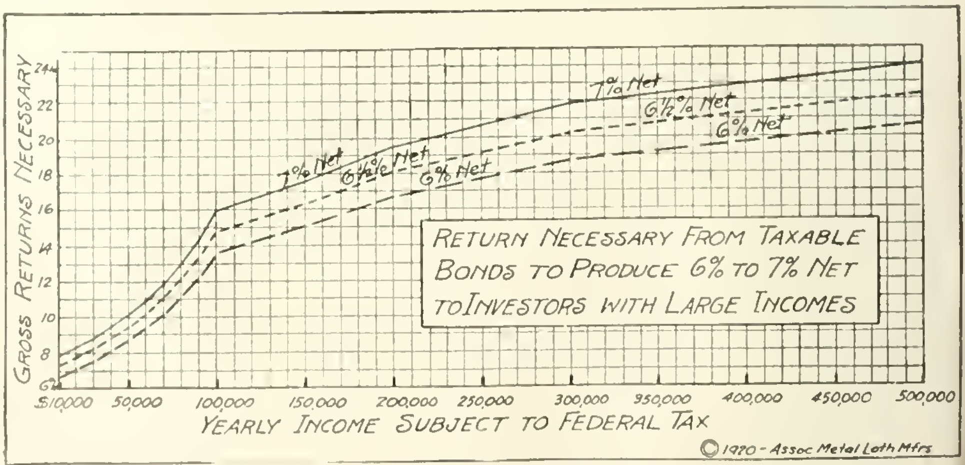
The building industry is at a stalemate. If new money is not provided by investors, the housing shortage will continue at its alarming rate, and in less than five years there will be 130 families to every 100 houses in the United States. What conditions will be under those circumstances, can be best pictured by the Health Department of the large cities that are already worrying over the rapidly spreading slum districts where the number of families obliged to live in one house is spreading disease and dissatisfaction throughout the community.

No one thing can be done that will be more effective than to speak to Congressmen on this subject and print the slogan on all letter-heads.

Method for Quantitative Measurement of Consistency

Some time ago the U. S. Bureau of Standards developed a method for the quantitative measurement of plasticity. This was described in Scientific Paper No. 278, and proved of great commercial value. Papers on the application of the method to paints have appeared in the Proceedings of the American Society for Testing Materials in 1919 and 1920.

The general method is to force the substance under investigation through a capillary tube by means of air pressure. The pressure is kept constant during any one run, but runs are made at various pressures with the same substance. The two values which are deduced from the readings thus obtained, determine the consistency, but do not determine the plasticity as defined for mortars and plasters. In this latter sense, as described in Technologic Paper No. 169, plasticity depends upon other factors besides consistency.



Return Necessary from Taxable Bonds to Produce 6 Per Cent to 7 Per Cent to Investors with Large Incomes.

At the present time, according to the September Technical News Bulletin of the Bureau, an investigation is in progress at the Bureau in regard to the application of the plastometer, as used for paints, to adhesives such as starches and dextrines. This work is being done by an Industrial Associate under the general direction of a member of the Bureau's staff. The indications are that the quantitative measurement of the consistency of adhesives of definite concentration will do much to enable manufacturers to predict the exact behavior of their products in service.

Strain Gauges and Methods of Using Them in Niagara Arch Revision

In connection with the revision of the Niagara railway arch bridge, described in the June 23 issue of Engineering and Contracting an extensive series of strain gage readings were made. A description of the method of making these readings was given by Mr. Charles Evans Fowler in a paper* presented June 2 before the American Society of Civil Engineers. The following details of this particular feature are abstracted from his paper.

The greater part of the work of measuring stresses was done by the use of the well known Berry strain gage, using the 8-in. gage for secondary stress work, and the 20-in. gage for primary stresses. These instruments (Fig. 1) have the side strips made of "Invar" metal, the coefficient of expansion of which is only about one twenty-eighth that of carbon steel, and the handling during use does not seriously affect the accuracy of the readings. One end has a fixed conical point, and the other end is a movable conical steel point attached to a bell-crank lever. The long arm of this is attached to the spindle of an Ames gage dial, and the lever has a multiplication of five times, so that while readings are made directly to 0.0002 in., they may be estimated to 0.00002 in.

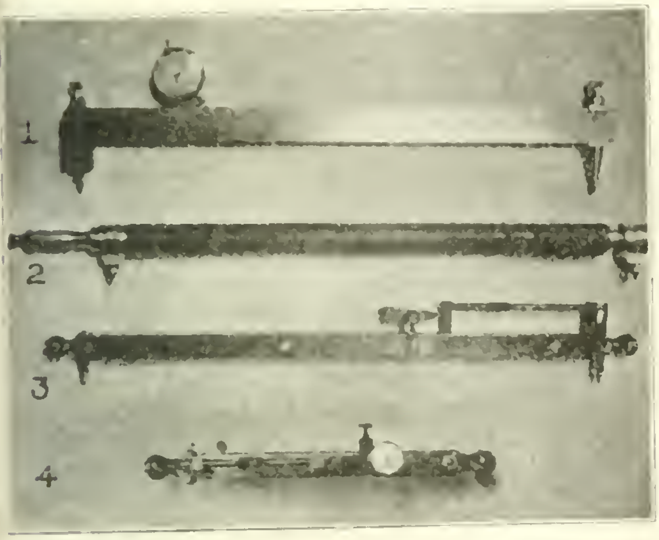


Fig. 1—Strain Gauges. (1) Berry 20-in. Gauge. (2) Howard 20-in. Gauge. (3) Fuller-West 20-in. Gauge. (4) Fuller-West 8-in. Gauge, Top View.

All the instruments were carefully calibrated to determine their error, by the use of a standard micrometer screw, and all three Berry instruments were found to read slightly high, one 3 per cent, one 3½ per cent, and the greatest error was 4 per cent on the third gage. These errors were of course constant, and as they were far within the degree of accuracy desired, no correction for this has been made in the results as given in the tables.

The Howard gage (Fig. 1) used on the Hell Gate Bridge was kindly loaned by Gustav Lindenthal for the purpose of making some comparative readings to determine the respective accuracy of the Berry, the Howard, and the Fuller-West instrument described in the following paragraph. The Howard gage has one fixed and one movable conical steel point, the movable one having a horizontal sliding movement and being attached to a rod sliding in the tube which carries the fixed point. The distance between the two points is read by a micrometer contact screw at the end of the tube next to the movable point, and reads to 0.0001 in. There are two milled heads with a spring ratchet between them which slips where contact is made. The inside milled head may be used, the operator depending on the sense of touch for the contact, or the ratchet outside head may be used. This instrument, not being made of Invar metal, is covered with leather for protection from heat in handling.

A New Strain Gage.—The Howard gage obviously cannot be used except for static load readings, and while the Berry instrument was used with moving loads and for impact readings, the excessive vibration of the needle of the Ames dial made it difficult for the observer to get accurate readings of the maximum stress at all times, and, therefore, many check readings were required. This led Professor Fuller to an investigation of the "Last Word" dial made in Cleveland, O., and to the construction of a much more reliable instrument, using this dial, by Mechanician West of Lafayette College, embodying Professor Fuller's ideas and some suggestions from the writer. The instrument, called the "Fuller-West," is shown in the two lower figures of Fig. 1. It is provided with fibroid handles to obviate trouble from change of temperature in handling. The joint of the movable point lever is a double cone pivot and much more accurate readings of moving load stresses can be made, and for static stresses it has been found to be more accurate than the Berry, or, in other words, where from 8 to 10 readings were made on a point with the Berry, a less number and one check reading with the Fuller-West instrument gave just as reliable results.

Standard Bars.—Two bars were made from pieces of $^3/_4$-in. gas pipe, long enough to allow caps to be screwed on to the ends and not interfere with the gage points 20 in. apart. The caps were screwed on tight and were then ground down flat on one side to give a flat base to rest upon. In the center of each a slot was cut on the opposite side and a thermometer placed inside where it could easily be read. These standard bars were marked A and B.

In making observations a reading with the gage was made on the standard bar, a group of points on members read, and then a check reading was made on the standard bar. The thermometer was read and recorded each time the standard bar was read.

Corrections for Temperature.—These were made from readings of special Fahrenheit thermometers which had been calibrated by comparison with a standard laboratory thermometer. The thermometers, 12 in number, were fastened in close contact to the members of the bridge and the bulbs bedded in putty to protect them from the air. The locations were changed as the work progressed. It was not considered necessary to have a thermometer on each bar or member when it was being read for stress, but the temperatures were read at the same hours for members similarly located. Very large differences, up to 27°, were found on opposite sides of a member—in the sun or away from it. The corrections for temperature were made by taking the coefficient of expansion of the steel in the bridge as 0.0000065. All the thermometers were kept in the shade.

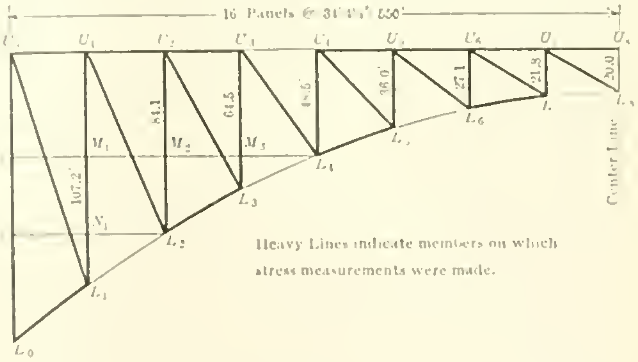


Fig. 2—Members of Niagara Arch to Which Strain Gauges Were Applied.

Members Read for Stress.—The members read for stress are shown by the heavy lines in Fig. 2. The members of the northeast quarter of the arch, down stream on the American end, were read most extensively, as that was more shaded from the sun. Members in the other quarters of the arch were read in sufficient number to give a check on this northeast quarter.

Gage Points.—These were located on the upper part of the arch so as to be easily reached from the highway deck, and by means of low staging or ladders. The points for secondary stress were located near the main top gussets and in large enough numbers to obtain results for both longitudinal and transverse secondary stresses. Points were located on Post U_1 L_1 at two elevations below the highway deck, and for the arched chord they were located inside the chord members. The location of the temporary and permanent gage points was recorded in tabular form.

---

*Revision of The Niagara Railway Arch Bridge, Proceedings Am. Soc. C. E., Vol. XLVI, No. 5, pp. 711-791.

Spots about 1½ in. in diameter were cleaned of paint and rust and placed either 8 in. or 20 in apart as needed. The holes for the "points" were drilled with a Yankee drill about 1/16 in. deep, and with a No. 56 drill The burr was removed by a flat-angle countersink and finished by rubbing with a center punch. One hole of each pair was finished before the other was marked, by using a bar with center punches spaced 8 in. apart. The holes were protected when not in use by filling them with vaseline.

Permanent gage points were placed on members, as indicated in a list in the company files, so that readings on such members could be checked up for different loadings at any future time. These points were set in the bottom of ½-in. holes ¼ in. deep, which were tapped and provided with cap-screws having a lead washer under the heads. The holes were filled with vaseline before the cap-screws were put in place.

Modulus of Elasticity.—The modulus of the steel in the bridge is the basis on which the strain-gage readings have been reduced, and this is undoubtedly 29,000,000 lb. per square inch. The character of the material was specified to be steel having a strength of from 60,000 to 68,000 lb. per square inch and an elastic limit of at least 33,000 lb. per square inch. It should be noted, however, that the steel was really only of 30,000 lb. elastic limit, as the value determined by the drop of the beam of the testing machine was what is now termed the yield point, and 30,000 lb. has been used as the real value of the elastic limit.

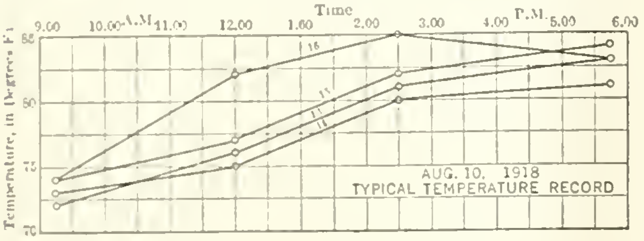


Fig. 3—Typical Temperature Record.

The original tests of the material were obtained by the writer from R. W. Hunt & Co., of Pittsburgh, Pa., successors to G. W. G. Ferris & Co., the original inspectors of the steel in 1896 and 1897. These tests show the yield point to be as specified for the elastic limit, and therefore the elastic limit used in determining the proper load to put on the arch and approaches, has been taken at 30,000 lb.

Recording Stress Measurements.—The stress measurements or readings were recorded after the manner shown on the typical sheet, Table I. In the first column, headed "Load," D L represents the static train load, and the letters refer to the standard trains, the details of each train being recorded in a record of "Test Loads." The date of the readings is given in the second column, and the exact hour in the third column. This enabled exact co-ordination of temperatures taken from sheets similar to Fig. 3. The first of the three columns headed "Temperature" gives the reading of the thermometers in the standard bars. Two standard bars were needed one for each observation crew, and these were standardized one with the other, so that readings could be compared, and with duplicate bars kept in the fireproof vault, so that in case of loss they could be replaced. The second temperature column headed "Arch" contains the temperature as reduced from a large number of thermometers at various places on the structure, and represents the values used in making corrections for temperature stresses. The third temperature column gives that of the member read and was determined from thermometers fastened directly to the member, or to one adjacent.

The results in the numbered columns are the strain gage dial units for the corresponding numbered point on the cross-section of the member in Table II. The figures given are the averages of all the readings for that point, which were always two or more independent readings Two temperature corrections were made for some of them, one, where there was a difference between the temperature of the member and the standard bar, and the other due to the temperature stresses in the arch The large figures are the corrected ones and the small ones the original, thus making it possible to check the temperature corrections at any time.

The tables of live load stress measurements, Table II being typical, give the deformations in dial units which are direct deductions from the dead and live load averages, and the stresses in pounds per square inch which have been computed from the deformations. An average of all the unit stresses in one member has been made and the area is given, thus making it possible readily to determine the total stress in the member.

About 400 gauge points were read on the members shown in heavy lines in Fig. 2 and upward of 5,000 individual and check readings made to establish the unit stresses. The readings were made in the cooler hours of each day so far as this was possible, but careful records of the temperatures were made as noted, and kept on some 50 diagrams similar to Fig. 3.

The comparisons made by calculating the stresses for certain members due to the strain used in the location for maximum stress, indicated that the results obtained by the strain-gauge readings were in error only from 4 to 6 per cent. This, of course, would not be true for members having very low unit stresses, as the unit stress must be of considerable amount to obtain an accurate result with the strain gauge; or in other words, the error in the strain gauge is largely

TABLE I—TYPICAL STRAIN-GAUGE RECORD.

Dead and Live Load Averages, in Dial Units.

Load.	Date.	Time.	Temperature. Standard.	Temperature. Arch.	Temperature. Member.	Standard.	Points. 1	2	3	4	6	6
VERTICAL $U_0 L_0$, BOTTOM.—GAUGE LENGTH 20 IN.												
D.L.	10-14	11.00	49	49	49	B	— 41 — 41	— 22 — 22	— 35 — 35	— 42 — 42	....	....
C_1"	10-16	8.40	53	53	52	B	— 26 — 26	— 8 — 8	— 22 — 22	— 29 — 29	....	....
VERTICAL $U_0 L_0$, TOP.—GAUGE LENGTH 20 IN.												
D.L.	8-13	11.30	84	85	83	A	— 56 — 57	— 43 — 43	— 49 — 49	— 39 — 39	— 66 + 66	+ 18 + 18
D.L.	8-20	7.40	61	61	60	A	— 52 — 53	— 41 — 42	— 46 — 47	— 37 — 38	— 64 — 65	+ 22 + 21
Dead load mean				70	......	......	— 55	— 42	— 48	— 38	— 66	+ 20
A_1	8-15	9.20	65	66	65	A	— 42 — 42	— 27 — 27	— 40 — 40	— 30 — 30	— 54 — 53	+ 26 + 26
C_1	8-20	8.35	64	68	62	A	— 35 — 36	— 22 — 23	— 36 — 37	— 28 — 29	— 51 — 62	+ 29 + 28
C_1'	8-20	9.00	65	64	63	A	— 34 — 35	— 22 — 23	— 36 — 37	— 28 — 29	— 50 — 51	+ 29 + 28
VERTICAL $U_1 L_1$.—GAUGE LENGTH 20 IN												
D.L.	10-13	11.50	60	62	62	B	— 79 — 78	— 70 — 69	— 63 — 62	+ 96 + 97	+ 24 + 25	— 55 — 54
C_2"	10-16	9.10	52	53	53	B	— 64 — 64	— 54 — 54	— 58 — 58	+102 +102	+ 34 + 31	— 42 — 42

TABLE II—UNIT STRESSES IN ARCH POSTS FROM STRAIN-GAUGE READINGS

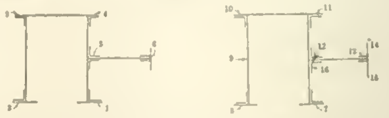
Stresses, in pounds per square inch, — sign = compression.

Deformations in Dial Units—1 Dial Unit = [illegible] In.

LIVE LOAD STRESS MEASUREMENTS.

Gauge Length, 20 In.

Member	Load	Points. 1	2	3	4	[illegible]	6	Average.	Area in square inches
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



MEASUREMENTS FOR LIVE LOAD SECONDARIES.

Gauge Length, 8 In.

Member	Load	Points. 7	8	9	10	11	12	13	14	15	16	Average
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

fixed in amount, and would, therefore, increase as a percentage the smaller the unit stress.

The practical uses for the strain gauge in actual construction or maintenance work on bridges were found to be many. Pending the substitution of stiff sway bracing instead of the rods in the 550-ft. arch span, it was necessary carefully to adjust all of them, some 96 in number, previous to the fall and winter of 1918; the former most careful adjustments by careful judgment were found to have put very little initial tension into some of the rods and too much into others. Some were found with 27,000 to 28,000 lb. per square inch, or practically up to the elastic limit of the bars, which were of [illegible]. They were all adjusted with the use of the strain gauge for an initial stress of 7,000 lb. per square inch.

Effect of Tannic Acid on Strength of Concrete

It has long been recognized that impurities of an organic nature have the effect of reducing the strength of concrete or entirely destroying the hydraulic properties of the cement. While this fact has been pointed out by a number of writers, there is still a tendency among concrete engineers to disregard the effect of such impurities. A general investigation of this subject was inaugurated in 1915 and has been continued during the past four years as a part of the investigations being carried out through the co-operation of Lewis Institute and the Portland Cement Association.

It was impossible to secure natural sands containing graduated percentages of organic impurities for a study of the quantitative effect of such impurities. Consequently, aggregate samples were prepared in which known quantities of organic impurities were present, by applying tannic acid as a surface coating in quantities up to 0.10 per cent by weight. Compression tests were made on 3 by 6-in. concrete cylinders. The mix varied from 1:5 to 1:2; the size of aggregate ranged from a fine sand to a $\frac{3}{4}$-in. graded aggregate. Tests were made on all mixtures and sizes of aggregate at ages of 7 days, 28 days, 3 months, 1 year, and 2 years. Specimens were stored in damp sand. This series included about 2,000 concrete tests.

The principal conclusions from this investigation are summarized as follows by Prof. Duff A. Abrams of Lewis Institute in a paper presented at the recent annual meeting of the American Society for Testing Materials.

It is believed that the results of these tests are typical of the effect produced by organic impurities in concrete.

The strength of concrete was reduced for all percentages of tannic acid, for all mixes and ages covered by these tests. Less than 0.1 per cent of tannic acid in terms of the weight of the aggregate may reduce the strength of the concrete to one-half its normal value.

Lean mixtures are more affected by tannic acid than rich ones. The mixtures from the finer aggregates are less affected by tannic acid than those from coarser aggregates.

All of the effects mentioned above may be summed up by saying that the reduction in strength of concrete is a function of the concentration of tannic acid in the mixing water. An equation is given which represents this relation for the 28-day tests.

The results of these tests indicate that the wetter consistencies would be less affected by the presence of organic impurities than the drier ones.

The strength falls off rapidly for small percentages of tannic acid and less rapidly as higher percentages are reached.

The 7 and 28-day strengths are reduced to a greater extent by tannic acid than at ages of 1 and 2 years.

Some of the 1:5 mixes in which the higher percentages of tannic acid and the finer sands were used (2 to 3 per cent solution) disintegrated before the time of test. The 1:7 mixes (3 to 5 per cent solution) were destroyed in removing the molds.

The tests confirm the results of many other investigations made in the Structural Material Research of Lewis Institute in showing the fundamental dependency of strength of concrete on the quantity of mixing water as expressed by the water-ratio.

The strength of concrete (stored in a damp place) both with and without tannic acid increased with age. The strength for a given condition was a logarithmic function of the age.

Considerations Affecting Design of Highway Bridges*

By LEWIS M. GRAM,

Professor of Structural Engineering, University of Michigan, Ann Arbor, Mich.

The amazing progress which has been made in highway engineering organization in general during the past decade or two has naturally brought about radical changes in practices relating to highway structures which form such an important part of the road system. Men who make a scientific study of the highway problems, nowadays, in general, are of the calibre necessary to handle intelligently practically all of their bridges, at least in so far as general specifications are concerned.

The author has recently taken occasion to examine some of the publications issued by the public road organizations in various states and is gratified to see in the treatment of structures the reflection of highly competent engineering counsel. In fact, in glancing through the structural specifications as embodied in the documents of such organizations as referred to, one is quite likely to note the similarity to those of well-developed railway practice. And why not? The problems are much the same and certainly no one who is familiar with the situation in structural engineering fails to recognize and appreciate the competency of the engineering corps who have been instrumental in developing railway construction to its present high standard. Loose and general specifications are no longer sufficient in the matter of of highway structures any more than for those on railways, and the highway engineer must consider it part of his duty to give special attention to each and every structure which forms an integral part of his road system.

Careful surveys should be made of service requirements, both immediate and future, in order that the general specifications may be prepared accordingly. To follow the railway analogy a little further, for example, the particular highway in question, with its incidental structures, may form part of a present or future main line where the traffic is, or likely to be, heavy and infrequent; or it may be a branch line where the demands are comparatively light.

There are many problems which the highway engineer must take up and solve at the outset concerning the design of a bridge structure, of which the following are the most important:

1. Type of structure;
2. Material best adapted for structure;
3. Capacity, both as to the volume of traffic which may be accommodated at one time, and as to its weight.

Capacity of Structure.—The type of structure and material best adapted for the structure are decided upon after a careful study of the economic and aesthetic features of the case in hand, and it is the intent to discuss here merely the third problem—namely, capacity of the structure and more particularly the weight of service traffic. At the outset it is proper to note that this point, involving as it does speculation on future requirements, can be handled with least scientific certainty. All will readily agree that in hazarding a prophecy regarding the future in highway transportation one guess is as good as another. Recently an item appeared in the public press to the effect that a patrol had been stationed along one of our recently completed public highways for the purpose of preventing the passage of motor vehicles of a capacity considered detrimental to the road structure. If that report be true, here we have an example of a transportation line excessively loaded almost as soon as it is completed for service, an engineering error, if it be so considered, which is excusable only when we stop to think of the almost unbelievably rapid development of highway transportation during the past few years. If the roadway surface is seriously impaired by excessive loading and speed, how much more dangerous is the effect upon the bridges which it is assumed are designed for the same loading as other parts of the same road division.

The following paragraph, pertinent to the situation, is extracted from an address delivered by H. E. Breed at the Highway Transport Conference in New York on Jan. 10.

> There is a pressing problem before all of us, upon which you should take immediate action. You all know the danger and de-

---

*From an address presented at 6th Annual Short Course in Highway Engineering at the University of Michigan.

[illegible] caused by weak bridges. Bridges have lagged farthest behind in improvement because they are not regarded as an integral part of the highway system. Along roads that are bearing 14-ton loads you constantly meet bridges designed for only 10 tons. In New York state there are 33,775 bridges. Of a total of 251 bridges on three main traveled routes from the Pennsylvania state line to New York City, only 115 are built for 15 tons or over; 17½ per cent of them are built for less than a 5-ton load. Twenty-three of them would stand less than 3 tons. On the less traveled routes the status of bridges is even worse. It is as menacing in other states as it is in New York. This matter should be rectified at once by petitioning our legislatures for funds with which to bring our bridges up to required capacity. Otherwise the progress of our whole system is threatened by its weakest link.

But it is not necessary to go all the way to New York state for example of weak highway bridges. We have them in our own midst, and why some of our structures safely carry the loads which are passing over them daily is a miracle of science which I will not attempt to explain.

Radical Changes in Bridge Specifications. What the future development in highway transportation will be no one of course knows, but there is certainly no excuse for failing to provide for present general needs in proposed highway structures, and also for making at least modest provisions for the future. It is not out of place to ask in this connection whether the highway proper and its incidental structures should not serve as a stimulus to encourage even more rapid development of transportation facilities. There are enonomic propositions involved, doubtless, in an answer to this question, and perhaps you have already considered it from the roadway proper angle. I wish only to say here that whatever decision may be reached regarding the roadway proper, applies with greater emphasis to the highway structures, because the weakness or failure of a single structure may tie up, for a time at least, an entire section of the highway.

A study of the specifications of 29 truck manufacturers collected by the highway department of the University of Michigan discloses the fact that while practically all of them are turning out vehicles weighing from 10 to 12 tons loaded, 15-ton trucks are not at all uncommon. In view of existing traffic requirements, therefore, one can hardly be criticised or considered too enthusiastic on highway transportation to predict the commercial use of motor vehicles weighing, loaded, as much as 21 tons, during the reasonable lifetime of a permanent structure. Some of our state highway departments even now wisely recognize the probability of continually growing traffic demands and specify design loads of that magnitude for their permanent concrete bridges.

With regard to the volume capacity of highway bridges, the ever increasing widths of motor vehicles and the speed with which they are propelled is again causing radical changes in bridge specifications. Where 18, 16, or even 14 ft. was formerly considered sufficient to provide for two lines of slowly moving traffic, many vehicles are now being used on the highways which require at least 8 ft. of width and on that basis it is my judgment that 20 ft. should be provided for two lines of vehicles on bridges of the main traveled routes, and 38 ft. for four lines of vehicles.

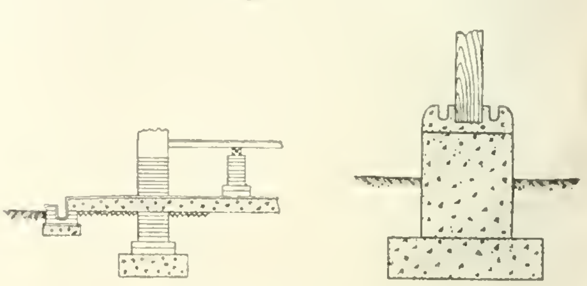
Points to Be Considered in Bridge Design.—To those who are interested in the technical design of highway structures there are various interesting points to be taken into account, some of which have already been made the subject of experimental investigation and others which should be so investigated at the earliest possible date. One such point of which mention might be made is the distribution laterally and longitudinally of concentrated loads. An engineer familiar with the designing of bridge structures will appreciate that concentrated wheel loads, instead of nominal uniformly distributed live loads, usually control in proportioning members of the floor system. A study of current practice in various states shows, however, that there is a lack of uniformity in the method of handling concentrated loads, differing by several hundred per cent. It will be seen, therefore that for the same traffic requirements a wide range of results is obtained due to varying judgment in the methods of applying concentrated loads in the design. Perhaps the most liberal and intelligent specification in this connection is that of the Bureau of Public Roads.

A second point of technical interest upon which authorities and specifications differ widely is that of impact. To what extent should the live load be increased in intensity due to the manner of its application? This is such a complex question, affected by so many conditions incident to both dead and live loads, that much experimental data will be needed upon which to base an intelligent answer for any particular type of structure. Investigations are now under way by the Bureau of Public Roads relative to the dynamic increase in weight of the wheel of a loaded truck on a road surface, showing that an increase of 2 to 400 per cent must reasonably be expected. A study of such data rather leads one to believe that insufficient importance has been attached heretofore to the matter of impact on highway structures; and it is hoped that investigations of similar nature may be made also on structures of various types.

In view of the rapidly increasing demands of traffic upon our highways, the importance of careful supervision and maintenance of highway structures should be emphasized. The engineer who is entrusted with responsibility for the highways in any given district should not only know the capacity of every structure under his care, in order that precautions may be taken to avoid accident due to inadvertent overloading, but he should see to it that the period of usefulness of every structure is prolonged by proper maintenance.

Ant Proofing Building Construction in Formosa

Much damage to buildings in Formosa is caused by the termite or white ant. Because of its subterranean and aerial habits it is very difficult to destroy the termite, or to guard against his insidious attack. Wooden buildings fall an easy prey to the termite. It also attacks the lime mortar in the joints of brick buildings. If the building is protected by a layer of concrete covering the entire foundation, subterranean attack is of course prevented. In this case the termite builds a tunnel of mud over the concrete foundation to reach the superstructure. Railway ties are, of course, wide open to attack. Even ships are not immune, as the ants, winged at certain periods of their career, fly out to the ships in the harbor.



Ant-Proof Building Construction.

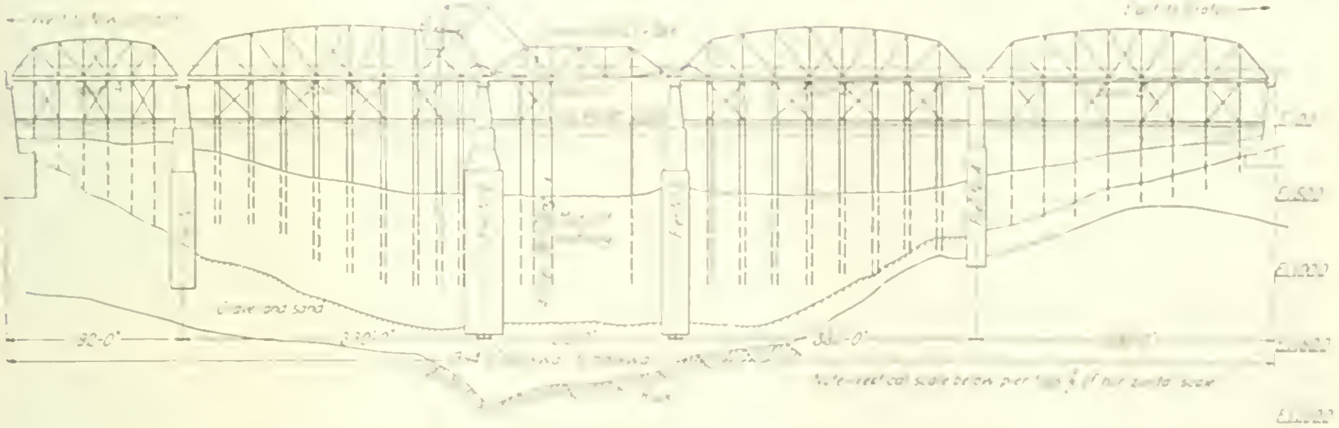
As it is impossible to eliminate all non-resistant timbers from a building, some method of excluding the termite is necessary. The first step is to treat the site of the foundation with a heavy crude oil. All footings must be of concrete, and a layer or shield of concrete must extend over the entire area of the foundation. Around the entire outer edge of this concrete base extends a channel or drain which is kept filled with water or non-volatile oil. Thus the termite is excluded from beneath. Should the drain go dry and he be able to cross it, his tunnel is easily detected. It is essential that the concrete shield be a monolith, otherwise the termite will penetrate the joints. In the Philippine Islands the concrete shield is often dispensed with, buildings being erected on concrete posts, extending well above the ground, each protected by a continuous oil channel.

But even these precautions are not enough. Unable to attack under or over ground, the termite has recourse to the air, entering the upper portions of the building. According to The Philippine Journal of Science, a very exhaustive test of many varieties of wood was conducted and only four were found to be entirely immune from damage. These were the Philippine woods, ipil and molave, and cypress and teak. These were hardly sufficient to meet the needs and experiments were made in the treatment of timber with various chemicals. Camphor green oil was found the most satisfactory, rendering many other woods in large measure immune from attack.

Method of Erecting Superstructure of Thames River Bridge

Unusual falsework methods [illegible] construction of the recently completed [illegible] & Hartford R. R. bridge over the T[illegible] Conn. The superstructure weighs [illegible] consists of double track through [illegible] span. Three of the fixed spans [illegible] in length and one is 186 ft. in length. The [illegible] ft. from c. to c. of piers. The substructure was constructed to carry four tracks. The bridge [illegible] of four fixed spans and a 500-ft. [illegible] site parallel to and 186 ft. downstream [illegible] of the new bridge. The construction [illegible] are described in the Railway Age [illegible] ing description of the erection methods [illegible] ture are abstracted.

The east and west approaches to the [illegible] of a 4-track fill about 30 ft. deep with [illegible] for the storage of steel, which was [illegible] and bottom of the fill. There was considerable navigation on the Thames River, and the channel could not be blocked for a period longer than one or two days. The distance from base of rail to mean low water of 39.6 ft., the considerable amount of unstable material such as mud, silt and clay on the river bottom and the depth of water, varying from 8 to 10 ft. at the abutments to 50 ft. at the channel, influenced the scheme of erection which was adopted.



General Elevation and Profile Showing the Falsework in Place.

One of the more important factors determining the scheme of erection was that of the necessary location of the new bridge. Because of the main line approaches it became imperative that the new structure be located as near as possible to the old in order to avoid any increase in the degree of curvature of the approaches. On account of the pile-supported center pier of the old bridge it was only possible to secure a minimum distance of 186 ft. between the two bridge tangents at this point. This location gave rise to a peculiar situation since the arms of the old draw span, 251 ft. 6 in. long, would foul the new bridge when the draw was opened. However, clearances were such that the draw span could be opened in a counter clockwise direction as shown in the diagram, with the bascule span closed, provided the fixed span "D" was not erected and on the other hand the draw span could be opened in a clockwise direction with span "D" erected provided the bascule was opened.

From the conditions at the site, the erection problem consisted essentially in the erection of the bridge in such a manner as to (1) maintain an open channel at all times and (2) permit the opening and closing of the old draw span. There was to be no railroad traffic over the new bridge during its erection, as traffic was not to be diverted from the old to the new until its entire completion.

Owing to the increase in train loading on the old bridge and the necessity of using the gauntlet method of operation with its resulting delays, the railroad required the most rapid scheme of erection. This requirement of speed in erection, together with the above mentioned conditions of the problem led to the use of the following scheme.

(1) Spans "A" and "B" were erected from the New London side, at the same time erecting span "E" from the Groton or eastern side, [illegible] through both [illegible] with the draw span swung in either direction.

(2) Navigation was permitted under "D" span [illegible] while the bascule span was erected in the raised position, the old draw being swung counter clockwise.

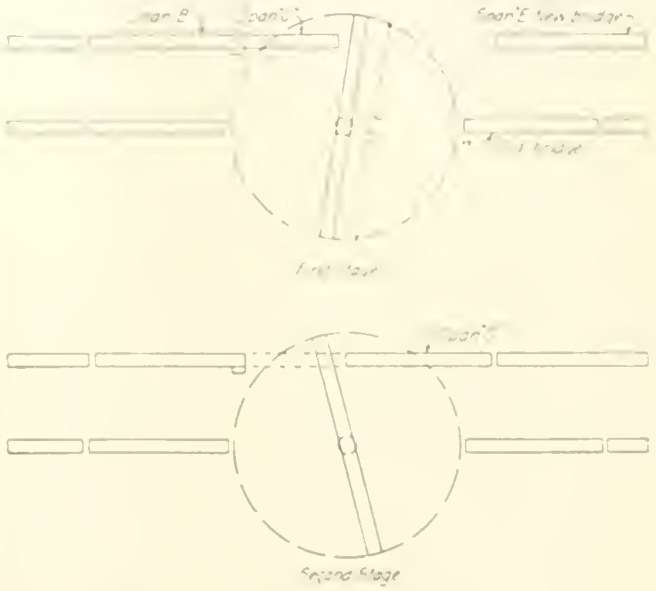
(3) The bascule span "C" was then lowered to the fully opened position, the draw span was swung clockwise and navigation was diverted to the west channel so that span "D" could be erected.

(4) The railroad traffic was diverted to the new bridge and the old draw swung clockwise with the bascule raised until a portion of the east arm of the draw span could be cut off.

The four fixed spans were erected on falsework. While the distance from base of rail to mean low water, the depth of water and the depth of unstable material on the river bed were not very favorable for falsework erection, nevertheless there did not appear to be any better or more economical method for the erection of the fixed spans.

The general procedure followed in the erection of the fixed spans was to build the falsework, erect the floor system and then the trusses on it, rivet the span, swing the span free from the falsework and finally remove the falsework.

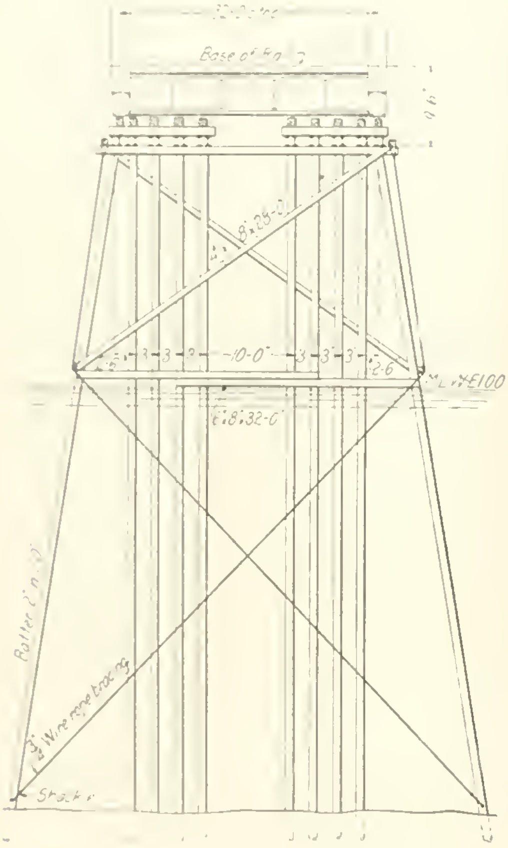
The falsework under span "A" consisted of 6-pile bents, under spans "B" and "D" of double bents of 8 piles each, and under span "E" of single bents of 10 piles each. The falsework required extra long piles, both because of the depth of water and from the unstable character of the upper section of the mud and silt stratum. Test piles driven at various locations showed that sufficient holding power could be secured by the stiff mud found in the deeper sections at



Sketch Showing How the New Bridge Was Erected to Avoid Interference with Operation of Old Draw Span.

elevations as low as 112 ft. below mean low water. This made necessary the use of piles varying in length from 60 ft. at the abutments to 136 ft. across the central portion of the structure and led to an interesting development in the falsework problem. As nearly 75 per cent of the 500 piles used in the falsework were of necessity of 120 ft. to 136 ft. in length, the expense of procuring ordinary round piles would have been very great, in addition there would also have been the greatly increased cost of handling, driving and framing such long pieces. Their salvage value would, of course, have been low. As the cost of the falsework amounted to a considerable item the following method was adopted and used with thoroughly satisfactory results throughout the work of erection:

The idea of using one-piece piles was discarded and the use of sawed timber adopted. The piles used consisted of 12 in. by 12-in. long leaf yellow pine timbers varying from 21 ft. to 34 ft. long and spliced at each joint by four 4-in. by 4 in. by ½ in. angles each 7 ft. long. A total of 28 ¾-in. bolts were used at each splice. This method rendered the driving of the piles comparatively simple as additional lengths could be added from time to time as the piles were driven thus obviating the necessity of handling piles of undue length. The piles were driven with a floating pile driver equipped with a 3,000-lb. hammer.



Elevation of Typical Falsework Bent.

The framing of the bents was of course simplified through the adoption of the sawed timber and a very stable bent was secured. The bents with long piles were braced transversely with a system of submarine cross-bracing consisting of two ¾-in. cables running from a point on each batter pile about even with the river bottom up and across the bent to the cross braces and then up to the deck as shown in the section of a typical bent. The penetration of the piles in the river bottom varied from 30 ft. to 60 ft. and each carried an estimated load of approximately 12 to 15 tons.

The steel was erected with two 60-ton locomotive cranes, the floor system being first erected. Bridge ties and rail for a single track in the center of the bridge were laid as the floor was placed. The members of the trusses were then erected in the following order: The bottom chord working from the fixed end of the span to the expansion end; the posts and diagonals in any order; the end posts and shoe pins, and then the top chords working from the center toward the ends.

Most of the bottom chord sections were two panels long and were set with two cranes. All members of the trusses were handled with erection hitches permitting the direct attachment of the hoisting block to the member and thus doing away with wire rope slings or chains. After the trusses and bracing were erected, the bottom chord splices, the connections of the diagonals and posts to the bottom chords and the floor system were riveted. The spans were then swung free of the falsework by knocking out the blocking and the remaining connections were riveted up. In order to facilitate erection, the top chord bracing of the inshore spans, although free of the falsework, was not placed until the midstream spans were erected. This procedure did not lead to any trouble from the swaying of the unbraced trusses but did permit the locomotive cranes to go back and forth over the end spans without lowering their booms.

The bascule is of the Strauss heel trunnion type, and consisted of the lift itself, the counterweight truss and box, the counterweight and the operating machinery. The lift itself was erected by cantilever erection, following the usual methods for this class of work, the permanent concrete counterweight being poured as the steel was placed in order to keep it in an approximately balanced condition. However, to take care of the unbalanced moment resulting from the locomotive crane running on and off of the lift and also to permit some variation in the amount of counterweight necessary to balance, a "hold-back" or erection strut was used.

This strut, capable of taking tension or compression, tied the counterweight trusses, and thus the lift itself, to one of the floor beams of span "B." The lift span was erected with a locomotive crane, while the counterweight box and trusses were erected with a 30-ton stiff-leg derrick placed on the top chord of span "B."

Tests of Permeability of Concrete

The U. S. Bureau of Standards has made some preliminary tests of a new apparatus for determining the rate of penetration of water through concrete and other permeable materials. The apparatus is so constructed that it is not necessary to mold the test piece in any particular shape, but any slab having one fairly smooth face may be tested. Only a few seconds are required for placing and adjusting the test specimen. This will permit specimens to be cut from walls or other portions of structures for tests. Tests so far made, while more in the nature of a try-out of the apparatus than the materials used, have furnished some rather interesting results.

In the following table reprinted from a Technical News Bulletin of the Bureau the results of tests on samples of building stones from various quarries, as well as on some mortar and concrete specimens, are shown. The specimens varied from 1¼ in. to 2½ in. in thickness and pressure was applied over an area of 25 sq. in.:

Test Specimen.	Absorption. in 24 hrs.	Thickness In.	Water Pressure. Lb.	Time required for penetration through wall.
Limestone, 50	5.80%	1 5/8	60	10½ minutes.
Limestone, 7E	3.10%	1 5/16	60	11 minutes.
Limestone, 8907 ..	1.40%	1 5/8	60	19 minutes.
Limestone, 9c	4.60%	1 5/8	60	2 2/3 minutes.
Limestone, 14F ...	3.81%	1 5/8	60	20 seconds.
Limestone, 5G	2.48%	1 1/4	60	1½ minutes.
Sandstone	5.56%	2 1/2	60	10 seconds.
1:6 Portland Cement Mortar..	7.8 %	2	60	3½ hours.
1:1½:2 Concrete ..	5.8 %	2	60	Did not fail in 24 hours; when broken through water had penetrated only ½ inch.

These results appear to bear out conclusions previously drawn in the Bureau's investigation of the durability of concrete in alkali soils that there is no apparent relation between absorption and permeability.

While considerable work must be done to standardize the method of making the permeability tests, it appears that this apparatus will assist in studying with a minimum of effort an important characteristic of concretes which has in the past been generally ignored, due to lack of suitable apparatus.

Effect of Floating Ice and Freezing and Thawing on Concrete Structures

In a communication to the [illegible] Civil Engineers on Deterioration [illegible] Sea Water, Mr. C. E. W. Dodwell, [illegible] at Halifax, N. S., of the Dominion Public [illegible] some experiences with ice piers at [illegible]. An abstract of Mr. Dodwell's communication [illegible] The Canadian Engineer, from which the [illegible] are abstracted.

A line of 10 piers was constructed [illegible] with the primary object of preventing [illegible] up and down with the ebb and flood tide, [illegible] shipping. The lower portions of piers 1 to [illegible] are of creosoted square timber, 12 in. by 10 in. [illegible] filled with stone ballast. The upper portions of these [illegible] of piers 6 to 10, inclusive, are of concrete. The lower portions of piers 6 and 7 are encased in watertight [illegible] of squared spruce. The piers from 1 ft. below to [illegible] above low water are faced or sheathed with birch (Betula lutea) plank [illegible] in. thick, and the corners are further protected by ½-in. steel cover plates.

The cement used in piers 1, 2 and 3 had following qualities by test:

Specific gravity	[illegible]
Fineness:	
Passing No. 50 sieve	[illegible]
Passing No. 100 sieve	[illegible]
Passing No. 200 sieve	[illegible]
Initial set of neat cement	[illegible]
Full set of neat cement	[illegible]
Percentage of water used	[illegible]
Average tensile strength of neat cement, 1 day in air and 6 in water	[illegible]
Average tensile strength, 1 cement, 3 sand, 1 day in air and 6 in water	[illegible]

CHEMICAL ANALYSIS

Silica	[illegible]
Alumina and ferric oxide	[illegible]
Lime	[illegible]
Magnesia	[illegible]
Sulph. anhydride	[illegible]
Loss on ignition	[illegible]

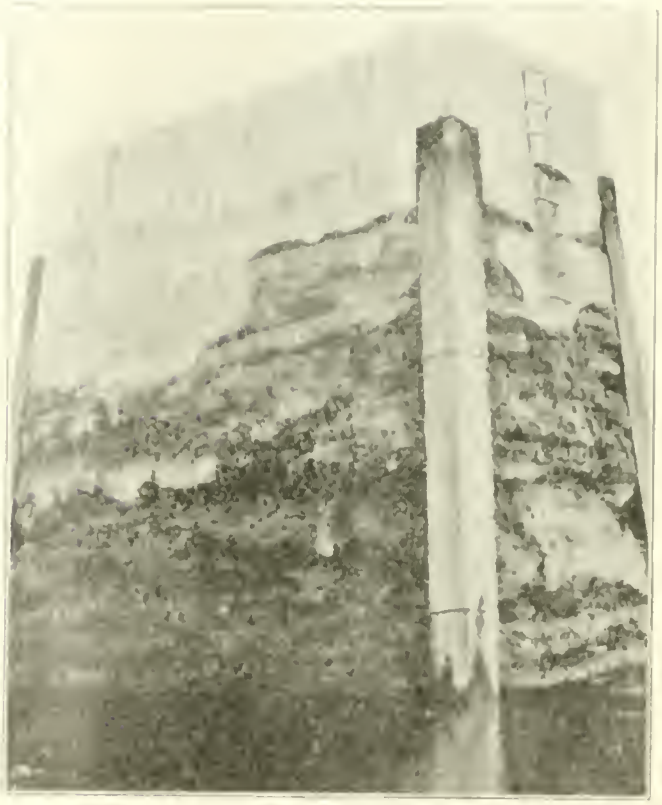
The concrete in pier 1, 2 and 3, built in May and June 1910 was composed of 1 volume of cement, 3 of clean, coarse pit sand and 3 parts of stone, broken to pass through a 2-in. ring. Displacers or "plums" of sound, clean stone, not exceeding 2 cu. ft. each, not less than 6 in. apart or 9 in. from any face, were laid as the work progressed.

The specifications provided that, as soon as the forms had been removed, the sides and top of each pier were to be rendered with a cream of equal parts of sand and cement trowelled to a smooth surface. On the top and the upper 4 or 5 ft. of the sides of the piers this skin coat held pretty well, but below high water mark it did not survive the first winter, owing to the difficulty in getting proper bond with the concrete that had been twice daily submerged.

The accompaning illustration shows the effects of the seven years' exposure of a typical pier, No. 2, to the attacks of floating ice, and the alternate freeze and thaw to which the rise and fall of tide subjected it.

It should be realized that it is impossible to determine the proportions of the disintegration of the surface concrete of the piers herein described, due to these two influences, respectively. Mr. Dodwell's opinion is that frost has had the major influence, but opinions are not evidence. No concrete is absolutely impervious, however rich it may be, however well rammed, or however excellent the quality of its several constituents. At high tide water penetrates its surface, if only to the depth of the fiftieth part of an inch. In a Nova Scotian winter the thermometer may be several degrees below zero F., and, as the tide recedes, the water in the concrete freezes, expanding as it does so. So long as the water in the surface of the concrete remains frozen, nothing appears to happen, but as soon as the tide again rises and the skin-water thaws the surface film of concrete falls off in powder. This action going on twice in the 24 hours during the four or five months of winter must inevitably result in the more or less rapid disintegration of [illegible] of any concrete exposed to such influences. That [illegible] action of floating ice also contributes to the disintegration of the concrete cannot, of course, be denied, for the illustration shows a number of steps (of 1-in. round iron) [illegible] the end of pier No. 2 much bent by the heavy [illegible] pieces of ice [illegible] must therefore strike or rub against the pier with considerable force.

Mr. Dodwell believes that had it been possible to make the concrete absolutely impervious it would have suffered very little from ice action, and that had it been possible to prevent floating ice from touching the piers, they would have shown almost as much deterioration as they have suffered under the two influences of surface freeze and thaw and the impact of ice. The maximum depth to which the concrete has been removed is about 1[illegible] in., and this depth is reached in very few places only. The average depth is less than 6 in., so that the actual diminution of bulk is inconsiderable. It is a singular but unmistakable fact that the disintegrating influences are slower in action now than they were during the first year or two. The causes of this retardation are as yet not quite clear, but Mr. Dodwell believes one of them to be the formation, growth or deposit of a coating or film of [illegible] on the surface of the concrete (to which the blackness



Appearance of Pier No. 2 in October, 1916, 6 Years After Completion.

to a certain extent from: The percolation of water, the freezing of the skin-water while the tide is out, or the falling in the accompanying illustration is due) which protects it away of the disintegrated surface film of concrete, and the consequent exposure of fresh surface.

As much as 4 or 5 years ago Mr. Dodwell fully expected to have been obliged to adopt some means of protecting piers 1, 2 and 3 from further deterioration, but it now seems that this may be deferred for another year or two.

Piers Nos. 4 and 5 were built in June and July, 1912, and with five years' exposure they do not show nearly so much deterioration as piers 1, 2 and 3, though this may be due to other causes than the lapse of less time. The outer 9 in. in thickness of the concrete was composed of 1 of cement, 3 of sand and 1 of gravel, all the rest of the concrete being 1 cement, 3 sand, 2 broken stone and 2 gravel, displacers being used in the treating. Two brands of cement were used. The qualities of one of these were:

Specific gravity	3.073
Fineness:	
Passing No. 50 sieve	.08%
Passing No. 100 sieve	1.44%
Passing No. 200 sieve	15.72%
Initial set of neat cement	1 hr. 32 min.
Full set of neat cement	3 hr. 57 min.
Percentage of water used	23
Average tensile strength of neat cement, 1 day in air and 6 in water	618 lb. per sq. in.
Average tensile strength, 1 cement, 3 sand, 1 day in air and 6 in water	287 lb. per sq. in.

CHEMICAL ANALYSIS

	Per cent.
Silica	22.44
Alumina and ferric oxide	9.14
Lime	62.26
Magnesia	1.98
Sulph. anhydride	1.02
Loss on ignition	1.75

Several hundred tests of the other cement (neat), 1 day in air and 6 in water, gave an average tensile strength of 796 lb. per sq. in. and a maximum of 900 lb. Briquettes of 1 cement and 3 sand gave at equal time an average of 330 and a maximum of 360, both classes of tests showing a very small margin between the maximum and minimum, thus indicating a cement of a very uniform and satisfactory character.

Piers 6 to 10 (the concrete portions) were built in December, 1913, and January, 1914. They have, therefore, had only 2½ years' exposure, and show but little deterioration.

Expansion Joints in Large Concrete Buildings

Some interesting information on the above subject is given by Mr. G. W. Maker of the Aberthaw Construction Co. in the September Successful Methods, from which we quote as follows:

Some engineers advise that expansion joints should be provided every 100 ft. to take care of the contraction and expansion of structures built of concrete. However, there can be found in nearly every city of magnitude concrete structures 300 ft. long constructed without expansion joints which have successfully withstood the changes due to variations in temperature and humidity. These structures indicate that if proper attention is paid to the method of reinforcement the difficulty can be overcome within wider limits than 100 ft.

Examples can be found of structures 400 ft. long that have shown no severe cracks after having passed through the intense heat of two summers and the severe cold of winter.

In general, however, for buildings over three stories high and over 300 ft. long, expansion joints should be provided. These joints should completely separate the buildings one from the other so that the different units will be free to move independently and of their own accord. This should preferably be done by means of double columns and double beams. The columns may rest upon the same footing as the movement would be practically negligible below the ground.

The adjacent column and beam should be cast after the forms for the first have been removed. In order to prevent the weather from coming through the space between the outside wall columns and the roof beams, metal diaphragm should be provided of either sheet lead or copper. This should be bent in the form of a "V" so as to allow it to expand as the two different units of the building move. The joints at the floor level should be protected by angle guards which prohibit the edge of the concrete from being broken. Sliding plates should be provided to prevent the dirt from sifting through to the floor below.

Another method of accomplishing this same result in providing a successful weather stop for the columns is to cast two grooves in the first section approximately 3 in. by 3 in. and coating with paint or pitch. In building the next section a tongue is formed by the concrete entering the grooves previously left.

How to "Kill" a Local Engineering Society.—(1) Don't come to the meetings. (2) If you do come, come late. (3) If the weather doesn't suit you, don't think of coming. (4) If you do attend a meeting find fault with the work of the officers and other members. (5) Never accept office, as it is easier to criticise than to do things. (6) Nevertheless, get sore if you are not appointed on the committee, but if you are do not attend committee meetings. (7) If asked by the chairman to give your opinion on some matter tell him you have nothing to say. After the meeting tell everyone how things ought to be done. (8) Do nothing more than is absolutely necessary, but when members roll up their sleeves and willingly, unselfishly use their ability to help matters along howl that the branch is run by a clique. (9) Hold back your dues as long as possible, or don't pay at all. (10) Don't bother about getting new members. "Let George do it."—Journal of The Engineering Institute of Canada.

Method of Stopping Leakage Through Stone Arch

Leakage through a stone arch carrying a canal over a creek was checked by concrete applied on the under surface of the masonry. The arch, which is near the passenger station in Trenton, N. J., has a span of 58 ft. and a width of 150 ft., and carries the Raritan Canal and a double track of the Pennsylvania R. R. The repairs were made early in the spring of 1917, at a time when the government, which was using the canal, found it impossible to shut off the water. The methods used are described by Mr. Harold P. Brown in the July Contractor's Atlas.

A 35-HP. boiler steaming at 100 lb. pressure was placed on the bank near the wall and pipes were run to the concrete atomizer located under the arch. A coke-burning salamander containing a 50-ft. coil of heavy 2-in. pipe was placed near the machine and steam at about 300° F. was directed against a few square feet of the surface of the arch until the stones were hot enough to vaporize the water leaking through. Then hot concrete at 50 lbs. pressure was jetted onto the hot stones and it set up before the water could force its way through. The mixture used contained 1 part of cement, 3 parts of sand and 2 parts of fine gravel.

It was found that if the pebbles were omitted from the jetted concrete, the material would not adhere to the surface through which water was leaking. In other words, the pebbles hammered the hot mortar into the cracks and crevices and checked the flow of water.

Many stones in the arch had a vitreous surface of great smoothness, but this did not prevent the concrete from adhering. From 4 to 6 in. of concrete was applied and no attempt was made to trowel or finish the surface.

The work was done from a float anchored in the creek; this was several times submerged during high water. Before the work was started it was feared that the steam released in the enclosed place would interfere with the visibility of the work, especially on days when there was no wind, but by inclining the jet towards one end of the arch, an air current was produced which kept the work visible to the operator though hidden from bystanders.

Mr. Brown states that the work has proved waterproof except at the masonry opening near the south and around the outlet provided for emptying the canal. Here the leaks around the plug were of such volume that no repairs could be made. Even when the canal was emptied at the end of the season the flow due to drainage interfered. The work has passed through three winters without cracking or peeling.

Cleaning Cement Sacks with Blower

A method of cleaning cement sacks which not only reduces the cost of this work, but also has resulted in recovering much cement, is employed at the store yard warehouse of the United Railways of St. Louis. The scheme is described in the Electric Railway Journal.

A No. 5 Buffalo blower is installed overhead with the intake pipe extending down to a point about waist high. The discharge from the blower is piped a short distance along the wall, where it connects to a cyclone separator. A cement sack is put over the mouth of the intake pipe. The suction draws the bag up into the pipe and turns it inside out. The workman then pulls it out and again puts it over the end of the intake, which turns the sack the other way out and sucks the cement from the opposite side. This process leaves the sacks cleaner than it is possible to get them by hand. The cement recovered is deposited in a sack attached to the bottom of the cyclone. By this means from one and one-half to two sacks of cement are recovered per 1,000 sacks cleaned. Two men can clean 2,000 sacks a day, besides sorting, counting and bundling them. The cement recovered makes a credit to the cost of handling of about $2.50 a day. The use of this machine makes the bag cleaning not a particularly undesirable job, and furthermore largely overcomes the spreading of cement dust over everything in the warehouse.

The Inventive Accomplishments of Thomas A. Edison During the War

In January 191[illegible] Thomas A. [illegible] was asked by Secretary Daniels to come to the aid of the country by devoting himself to the study and suggestion of such [illegible] inventions as might seem to Mr. Edison to be necessary if the United States should become involved in the war with the Central Powers. Accordingly Mr. Edison put his business affairs entirely in charge of his officials, gave up all of his experimental work and investigations, and devoted himself exclusively to this work for the Government [illegible] was engaged for about two years. What he accomplished during this time is told by Lloyd N. Scott in his book "Naval Consulting Board of the United States," published recently by the Government. The notes following are abstracted from the above mentioned publication.

At the beginning of this work Mr. Edison gathered around him, as assistants, such young engineers as were at the time in his employ. He also obtained some volunteers from various colleges and universities, and he prevailed upon some industrial concerns to assign a few of their technical men to come to the laboratory and help along in the work. Beside these, Mr. Edison had about 50 skilled mechanics in his laboratory workshops, on whom he could call for making experimental apparatus.

The ideas and devices were developed almost entirely by experiment, and those mentioned relate to naval equipment or operations and merely describe the first experimental results, and are not intended to be the final word on the subjects and do not go into all details. They were for the purpose of giving the Army and Navy officials the results of Mr. Edison's experiments and were intended to stimulate them to further inquiry for details and to continue the experiments if desirable.

A great many other experiments on different subjects were carried on but were not brought to a stage where definite reports could be made, such experiments being laid aside for subjects which at the time were deemed of more immediate importance.

A descriptive list of devices worked on by Mr. Edison includes the following:

Detecting Submarine by Sound from Moving Vessel.—When submarine activity began to play havoc with shipping the problem of detecting the location of submarines by sound was considered one of the foremost problems of the day, and in a very short time it was recognized as being perhaps the most difficult one.

Immediately on beginning his war work for the Government, Mr. Edison gave this problem a large part of his attention. He commenced with exhaustive experiments along the line of the induction balance, but after about two months of intensive work along this line he came to the conclusion that it was hopeless to find a solution in this type of device.

He therefore turned his attention to other means which seemed to him more promising. While conducting studies on various lines, he continued giving a great deal of personal attention to this problem all through the two years that he gave to the Government.

It is unnecessary to review in detail the vast number of experiments that he made in pursuing this line of inquiry. He passed through many stages of [illegible] [illegible] [illegible], towing devices, resonators, etc., and in the summer and fall of 1917 had reached a fair degree of success in detecting sounds of torpedoes as far as [illegible] yards [illegible]. These results were mostly obtained on board a vessel that was not moving, although in the case of the [illegible] [illegible] only fairly good results were had during the progress of the vessel. The noises caused by the [illegible] of [illegible] [illegible] against a towing device prevented the obtaining of as good results as in the other cases.

During the early months of these experiments submarine activity of the enemy had resulted in vast destruction of ships and Mr. Edison began to view the solution of the problem from a different angle. It [illegible] [illegible] to his mind that if it were possible to circumvent the submarines and avoid the loss of ships, the result would be as satisfactory as if the submarines themselves were destroyed. He, therefore, decided that if he could provide merchant ships with a listening apparatus that would enable them to hear the sound of the torpedo as soon as it was fired from the submarine and also provide the merchant ships with a means of changing their course rapidly at [illegible] [illegible] to [illegible] where the torpedo would [illegible] [illegible] [illegible] [illegible] [illegible] that would proceed on its way. If another torpedo were launched the same turning could be again resorted to.

Mr. Edison, therefore, proceeded along this line from that time on. After a time he discarded towing devices for the reasons above given, and he [illegible] conceived that if he could install on a ship a device [illegible] [illegible] so arranged that it would always be from [illegible] feet ahead of the bow of the vessel, and if this device [illegible] carry a vibrating diaphragm it would not have to contend with the noises of the ship itself [illegible] these could be compensated for and made to [illegible] [illegible] with the noises [illegible] by the rippling of water along the sides of the vessel nor water eddies affecting the [illegible] apparatus. As the result of a long line of [illegible] [illegible] experiments he constructed such a device which was in the form of an outrigger suspended from the bowsprit by a special designed appliance. This attachment was one by which the arm and bowsprit were connected to a worm actuated by an electric motor, whereby the bowsprit and arm could be swung in a circle toward the boat and the entire [illegible] [illegible] on the deck for making any necessary repairs. By this arrangement the listening device could be taken from and returned to position in the sea in a few minutes.

This device was afterwards given practical tests in very [illegible] [illegible], fulfilling all requirements, and was not in any way damaged or put out of commission even in the roughest kind of [illegible] sea, with the vessel going at full speed, 14 knots [illegible] [illegible].

With this device boats moving 1,700 yards away could be [illegible] heard while the vessel was going full speed. A submarine bell 5½ miles away could also be heard by the operator while a big storm was in progress and the boat also proceeding at full speed, and this with only plain diaphragms.

With this device there would be no difficulty whatever in hearing a torpedo more than 4,000 yards away, and this is far beyond the effective distance at which a torpedo can be launched from a submarine. The noise by a torpedo is very piercing and peculiarly distinctive.

During the course of Mr. Edison's experiments on detection by sound he had the use of several small steamers, one at a time, which were placed at his disposal by the Government for these experiments. Unfortunately, these respective vessels were not in the best of condition and were laid up for repairs at frequent intervals, and just as Mr. Edison had [illegible] the last experiments above named and had devised very sensitive apparatus to replace direct listening, the vessel was withdrawn by the Government and no other substituted, which, of course, put an end to the work.

Quick Turning of Ships. In connection with the listening device on board ships, Mr. Edison desired to provide cargo boats with a means of turning the ship very quickly to a right angle course on hearing the launching of a torpedo by his listening device. He believed he could accomplish this with sea anchors. He carried out a number of successful experiments on comparatively small boats, and then arranged for a life-sized test with a 5,000-ton ship loaded with 4,200 tons of coal.

Mr. Edison's plan included the use of four sea anchors each about 9 ft. in diameter at the mouth, and each attached to a 4-in. rope. The plan was to fasten the ends of these 4-in. ropes securely in the bow of the ship and to have the sea anchors placed at the end of the ropes and midway of the ship. If the observer at the listening device reported a torpedo launched by a submarine at a distance, the signal was [illegible] and the four sea anchors were to be immediately [illegible] [illegible] thrown overboard and the helm thrown hard over, bringing the ship almost to a standstill and turning her at right angles to her original course within a very short space of time and advancing only a short distance on her original course. In a test a loaded vessel 325 ft. in length was turned [illegible] from her course in 2 minutes 1[illegible] seconds, with an advance of only 200 ft., by the use of only four sea anchors. Without the sea anchors the ship made an advance of 1,000 ft. in turning.

Collision Mats.—One of the schemes suggested by Mr. Edison to minimize the loss of torpedoed vessels covered the [illegible] of collision mats according to a plan submitted to Washington. His arrangement contemplated the installation of 10 collision mats on each side of the vessel, each mat to be 40 ft. long and 35 ft. wide and rolled on a 6-in. pipe. Photographs of torpedoed ships furnished a clue to the best size for mats. These mats when rolled up and when not in use to be placed about 15 ft. away from the sides of the vessel, so as not to be affected by the explosion and out of the way of interfering with the launching of lifeboats. These mats were so arranged that any one of them could be launched in 15 seconds in such manner as to cover the hole made by the explosion. Mr. Edison built a rough model of a merchant ship on a scale of 1 in 25, on which the above plan was carried out on a small scale. He also launched a 10 by 10 ft. collision mat from a boat at sea as an experiment.

Camouflaging Ships and Burning Anthracite.—In July, 1917, officials from the Cunard Steamship Co. and the Submarine Defense Association had several interviews with Mr. Edison in regard to means of protection from submarine activity. He visited the steamship docks with a draftsman and after some experiments suggested to the Cunard Co. a scheme of camouflage. The scheme is described in a report forwarded by him to Washington, which reads in part as follows:

> As the distance which the smoke of a steamer can be seen from a submarine is about 20 miles, this gives a visibility area a circle 40 miles in diameter, or 1,600 circular miles.
>
> I have also advised the Cunard Co. to carry 200 tons of anthracite coal and to burn this only in the danger zone. This amount of coal will carry the vessel in and out of the zone, and the only extra expense for this is $275. I have also had the engineers of the New York Edison Co. teach the Cunard engineers how to effectively burn anthracite so there will be no loss of speed with any cargo boat, which type of boat is the only one that I am working on.
>
> By the suppression of smoke, the area of visibility is reduced from 1,600 circular miles down to 400 circular miles. To reduce this area still further, I suggested that masts be removed, as they are no longer used for sails, so as to help the steam power, and also that the height of the smokestack be diminished to half. With the masts removed and the funnels out, the visible area is still further cut from 400 circular miles to 114 circular miles.
>
> In addition to removing masts and cutting the stack, I have added a camouflage line of canvas strips tapering from bow to stern, the highest point being the stack.
>
> In fair weather a boom pole extends out from both ends of the ship, upon which ropes are hung, the distance apart of each rope being more and more as they recede from the ship. This further reduces the area of visibility.
>
> Two cargo boats of the Cunard Co. are being changed over to comply with the model and they will leave for England next week.
>
> The Submarine Defense Association has taken the matter up, and probably all cargo ships will soon make the changes suggested, which I am glad to say is very quickly done and rather inexpensive.

The Valerie, of the Cunard Line, was the first ship to be so camouflaged and Mr. Edison was told from outside sources that she ran for about a year by herself, but when put in a convoy was torpedoed and sunk.

It should be said that previous to Mr. Edison's recommendations to the Cunard Co. he had made investigations as to the possibility of changing over from bituminous to anthracite coal without changing grates. This point was definitely settled by actual tests made on voyages of coastwise steamships.

Obstructing Torpedoes with Nets.—Previous to the time that Mr. Edison evolved the idea of the quick turning of a ship to avoid an oncoming torpedo, as described heretofore, he was experimenting on a plan to enable merchant ships to [illegible] torpedoes launched at them by submarines.

Part of this plan was to use his listening device, by means of which a torpedo could be heard the moment it was launched. Mr. Edison proposed the use of a simple gun, similar to a trench mortar, from which should be fired an obstruction netting. This consisted of a small flotation tube, say, 25 ft. long, over which is wound a net of 1-ft. mesh made of quarter-inch cables of very fine steel wires, the net being coated each side with thin canvas. The whole would resemble a large window shade. When the net strikes the water it unfolds and extends down 25 ft.

The plan was that if the torpedo were heard advancing toward the boat a large number of these nets should be thrown in its path, giving sufficient retardation that it would be stopped or be so delayed as to miss the ship.

The powder suggested for the guns was a very slow-burning, of a special character to give a mean effective pressure, possibly of 200 to 400 lbs. per inch. In Mr. Edison's experiments he gained sufficient data to estimate that these nets could be delivered at least 950 ft. from the boat. The rolls did not tumble, but could be fired with remarkable accuracy.

Underwater Searchlight.—One of the problems placed before Mr. Edison was to provide a searchlight to be used under water by submarines.

At his request the New York Testing Laboratories made some experiments on arc projectors giving light of different wave lengths through long tubes filled with sea water and distilled water. Their facilities were not adequate for the extended experiments Mr. Edison desired to make on the absorption of light by sea water, and he continued the work in his laboratory, using arc lights with combination carbons carrying elementary substances.

After making a great number of experiments he found that the green line of barium in the arc penetrated salt water farther than any other he had observed. It was his impression that in blue water it might be possible to see an object 200 ft. ahead with rather powerful apparatus, and so reported to Washington, stating at the same time that he had reached a point where progress could not be made in the laboratory and that further experimenting should be done at sea.

It may be added that his last experiments were with a 60-ft. tube filled with sea water, at the end of which sufficient light was transmitted to read print.

In connection with these experiments Mr. Edison incidentally suggested a plan whereby the safest depth of water under a ship could be obtained while running.

Oleum Cloud Shells.—The experiments with shells containing oleum, which on bursting would form a dense white suffocating cloud, were followed up by Mr. Edison for several months. He was greatly impressed with the desirability of this type of shell for many purposes, especially for making a cloud to blind the vision of enemy ships. Their inexpensiveness, both intrinsic and comparative, appealed to his sense of economy, and their effectiveness was in his judgment desirable for the purpose. The oleum shell was in general of similar construction to other shells but contained a can of oleum instead of shrapnel, and also a bursting charge of T. N. T.

A year afterward it was stated that the Germans were using oleum shells toward the close of the war.

High-Speed Signaling with Searchlights.—The officials of the Brooklyn Navy Yard having expressed to Mr. Edison a desire for a device which would permit high-speed signaling with searchlights, he proceeded to experiment along this line and produced a device consisting of a Venetian shutter inclosed in a frame, the shutter being connected to an electromagnet in circuit with a battery and telegraph key. The working of the key actuated the electromagnet, this causing the shutters to open and close, and Morse signals could be flashed at the rate of 10 words a minute.

The device was sent to the Brooklyn Navy Yard.

Water-Penetrating Projectile.—It is well known that an ordinary projectile fired at sea will, on striking the water, ricochet and will not penetrate the water in a direct line so as to make a penetrative hit on a submerged target. During the height of enemy submarine activity, Mr. Edison also devised a type of projectile which would enter the water direct without ricochet, and which would continue its course without deflection and make a penetrative hit.

The following will be illustrative of the many tests made with this type of projectile. In these tests the gun (smoothbore) was 8 feet 3 inches above the water and distant 324 feet from the submerged target. Three-quarter service charged used.

Weight of projectile, 0.553 lbs.

Weight of container, 0.721 lb.

Weight of charge, 57 grams of service guncotton.

Shot No. 1: Water penetration, 7 ft.; effect on target, penetrated 1/32-in. sheet iron.

Shot No. 2: Water penetration, 80 ft.; effect on target, penetrated 7/62-in. steel plate and dented 7/62-in. steel plate situated beyond first plate.

Shot No. 3: Water penetration, 100 ft.; effect on target, penetrated 7/64-in. steel plate and 1/32-in. sheet iron.

The holes made in the target were clean, round holes indicating projectile had hit same normally.

Zigzagging Ships.—In the latter part of the year 1917 the naval officers of the Allies adopted a plan of having merchant ships in zigzag lines when proceeding through a danger zone. Having made many months' study of the submarine question and having collected a great [illegible] Mr. Edison reached the conclusion that it was [illegible] for merchant ships moving less than 10 knots an hour [illegible] and that the results only led to a loss of our time [illegible] capacity.

This conclusion was transmitted to Washington accompanied by an illustrative diagram. Mr. Edison learned subsequently that the French naval officers had arrived at the same conclusion.

Obtaining Nitrogen from the Air.—[illegible] years ago Mr. Edison was experimenting with the reduction of iron by hydrogen for his storage battery. In May, 1917, he remembered certain phenomena connected with these experiments, and communicated the same to Washington, thinking it might be interesting as revealing a process of obtaining nitrogen from the air, for use in explosives.

The substance of the communication was to the effect that in the experiments above referred to nitrogen and hydrogen were passed over the iron to render it [illegible]. In doing this a considerable quantity of ammonia developed, which was troublesome, but no special thought was given to it. It having appeared that the Germans were making nitric acid from ammonia, Mr. Edison set up his old apparatus again and found that by mixing lampblack with the reduced iron the passage of nitrogen and hydrogen over it produced ammonia continuously in large quantity, which he absorbed in acid.

A remarkable feature, to which Mr. Edison called attention, was that while the Germans were compelled to use high pressure, his process worked at ordinary pressure, and the investment required was exceedingly small.

Hydrogen Detector for Submarines.—The various explosions on submarines resulting from an excessive accumulation of hydrogen gas rendered it highly desirable to develop a reliable and simple hydrogen detector. Mr. Edison therefore devoted some thought to this subject and after a series of experiments produced an accurate and simple instrument which would indicate as small a quantity as three one-hundredths of 1 per cent of hydrogen in the atmosphere of a submarine. This instrument could be made in quantities for about $50.

Information relative to this hydrogen detector was forwarded to Washington, but the instrument was deemed to be too fragile. Mr. Edison subsequently placed one of these instruments on a submarine used constantly for maneuver practice. It remained on board nine months and was still all right at the end of that time.

Protecting Observers from Smokestack Gas.—Mr. Edison had been informed that, under certain conditions of the wind, splash observers on top of the masts suffered considerably from the gases emitted from the smokestacks of warships and that the effects of the sulphurous acid from the sulphur of the oil are very severe. He therefore developed a simple device which upon very severe tests proved its practicability to render the observer immune from the effects of the smokestack gas.

Device for Lookout Men.—A simple little device for use by lookout men in watching for periscopes in bright sunlight was suggested by Mr. Edison. It consisted of a tapering metallic box, open at both ends, fitted with a light excluding eyepiece and having diaphragms placed at intervals along its inside length. It was about 14 in. long and its greatest aperture was about 5 by 6 ins. The device was painted a dead black inside and out, and its construction was very cheap.

In practice about 75 per cent of the general glare would be cut off from the eye, allowing the pupil of the eye to dilate and making the vision much more sensitive. By the use of this device in full light of day objects could be discerned that were otherwise invisible.

Blinding Submarines and Smudging Periscopes.—Owing to the great activity of the enemy submarines Mr. Edison devoted a great deal of thought to various plans for preventing sinkings, and he suggested a number of schemes to this end.

One of these was a proposition to furnish merchant ships with a type of specially designed [illegible] shell filled with an oleum smoke-producing compound with which to blind submarines in cases where they had long range guns and where the merchant ships were helpless. The [illegible] of the shell proposed by Mr. Edison had been [illegible] out by him on land before submitting to Washington the following design.

Extinguishing Fires in Coal Bunkers.—One of the problems submitted to Mr. Edison related to means for extinguishing coal bunker fires on board warships.

After a series of experiments he suggested that a small stream of silicate of soda passed on a coal or wood fire was surprisingly efficient in extinguishing them. The moment the silicate of soda strikes the incandescent body the small quantity of water in the silicate evaporates and the glowing body becomes coated with a glassy surface excluding the oxygen and thus extinguishing the fire.

Direction Finder for Hostile Airplanes.—This development work was undertaken to determine the direction of a hostile airplane before it was visible, by determining the direction of the source of sound given off by its engine.

Mr. Edison's general plan was to arrange two horns at a fixed angle to one another arranged to convey the sound to opposite sides of the same diaphragm and to swing the horn system both in horizontal and vertical planes, until there was no movement of the diaphragm because the sounds conveyed by both horns were of equal value and therefore neutralized one another. It was found very difficult to get absolutely "zero readings," but with some training on the part of the observer the direction could be determined with considerable accuracy.

Sound Ranging.—The determination of the location of hidden guns by observing the time intervals between which the sound of their discharge reached several known points was early undertaken by Mr. Edison.

His idea was to develop apparatus that could be practically applied in the field and could be relied upon for accurate results under the varying unfavorable conditions that would likely prevail in practical service. He also considered it important to use the shortest possible "base line."

Mr. Edison had already performed a great many experiments with electric magnetic recorders in developing the telescribe, so that he was able to utilize the instruments developed in this study for the recording of gun sounds. It was found that the phonograph method of recording had peculiar advantages for this work.

Mr. Edison's constant endeavor was to keep the length of the base line short, and therefore his efforts were to keep the chance of error as low as possible in all his apparatus.

Actual tests, made with modern guns, showed that under varying weather conditions the position of an unknown sound could be located within 2 per cent, plus or minus, of the measured distance, with a base line not exceeding one-sixth of the range distance. Under favorable conditions some remarkably close results were obtained.

With a base line 1,800 ft. long (the longest base line used) the gun has been located over $2\frac{1}{2}$ miles away, within a foot or two of the actual position.

When records had been obtained on a particular type of gun for study, it could usually be identified by a trained observer from guns of other caliber.

Smudging Periscopes.—One of the early suggestions made by Mr. Edison was the use of a compound of "straw oil," Cuban asphalt, gilsonite, or Texas asphalted oil for producing a film on the waters in which submarines were operating. The object was to smudge the periscopes and render them useless for purposes of observation.

Having been informed by the Navy Department that compressed air and a stream of gasoline had been used to clear the periscope of any smudging compound, Mr. Edison continued his experiments and a few weeks later reported another compound of straw oil and a residue from benzol absorbing plants. This compound could not be removed from the periscope by either compressed air or gasoline. In fact, the use of compressed air or gasoline made the smudging more effective.

Preserving Submarine and Other Guns from Rust.—One of the problems submitted to Mr. Edison was to find some method of preserving submarine guns from rust.

He made a large number of experiments and finally found that if extra fine zinc dust is mixed with vaseline and smeared over the gun no rust whatever formed, either in air, or sprayed with sea water, or wholly immersed in fresh or sea water. If only plain vaseline was used the polished steel became badly rusted.

These experiments were conducted for several months in air, also submerged in fresh water and sea water, with entirely successful results.

Methods of Simplifying Making of Logarithmic Charts

In making alignment charts for calculating purposes the graduation of the scales is a slow and tedious task. This is especially so in the case of charts involving multiplication, division, powers or roots since the graduations are logarithmic. It is common practice to graduate the scales using a table of logarithms and an engineer's or decimal scale. Three schemes that have been found to be of considerable assistance in constructing these charts are described by Mr. John L. Alden in a recent issue of the American Machinist.

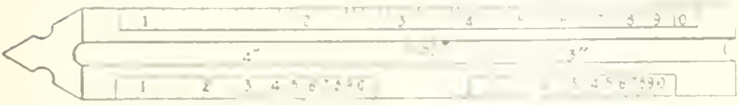


Fig. 1—Converted Architects' Scale.

The graduations on a triangular architect's scale were planed off, exposing the bare wood. Along the edges of the rule were glued logarithmic scales of paper, Fig. 1. The lengths of these scales for a complete unit from 1 to 10 are 2, 3, 4, 4.92, 6 and 9.85 in. The 4.92 and 9.85 in. scales are the half and full length of the 10 in. slide rule, and were cut from a diagram in a slide rule instruction book. One of these books will yield nearly a dozen scales. The rest of the scales were laid out and inked on bond paper.

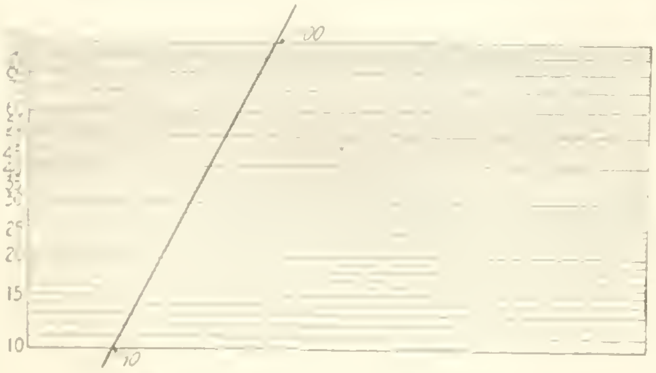


Fig. 3—Modified Logarithmic Diagram.

While the scales of two factors can be laid off in definite lengths on the chart, the scale of the third factor is usually an odd length which must be graduated especially. A logarithmic diagram constructed on tracing cloth, as shown in Fig. 2, may be used to advantage in laying off the desired divisions on such lines of indeterminate length. The vertical axis of this diagram must always be parallel to the line to be graduated. A modification is shown in Fig. 3. This is a rectangular diagram ruled on tracing cloth, which is to be placed diagonally on the line to be graduated. In each case the graduations must be pricked through the transparent cloth onto the line.

Mr. Alden has found that the two scales of slide rule length satisfy most requirements and are by far the most commonly used. He therefore constructed two scales of these lengths with graduating lines about 10 in. long, similar to Fig. 3. These were blueprinted and cut up into strips 1/8 in. wide, each of which is a complete logarithmic scale. These scales may be pasted to the proper lines of the chart, leaving the only lines to be graduated the scales of odd length for the third and succeeding factors.

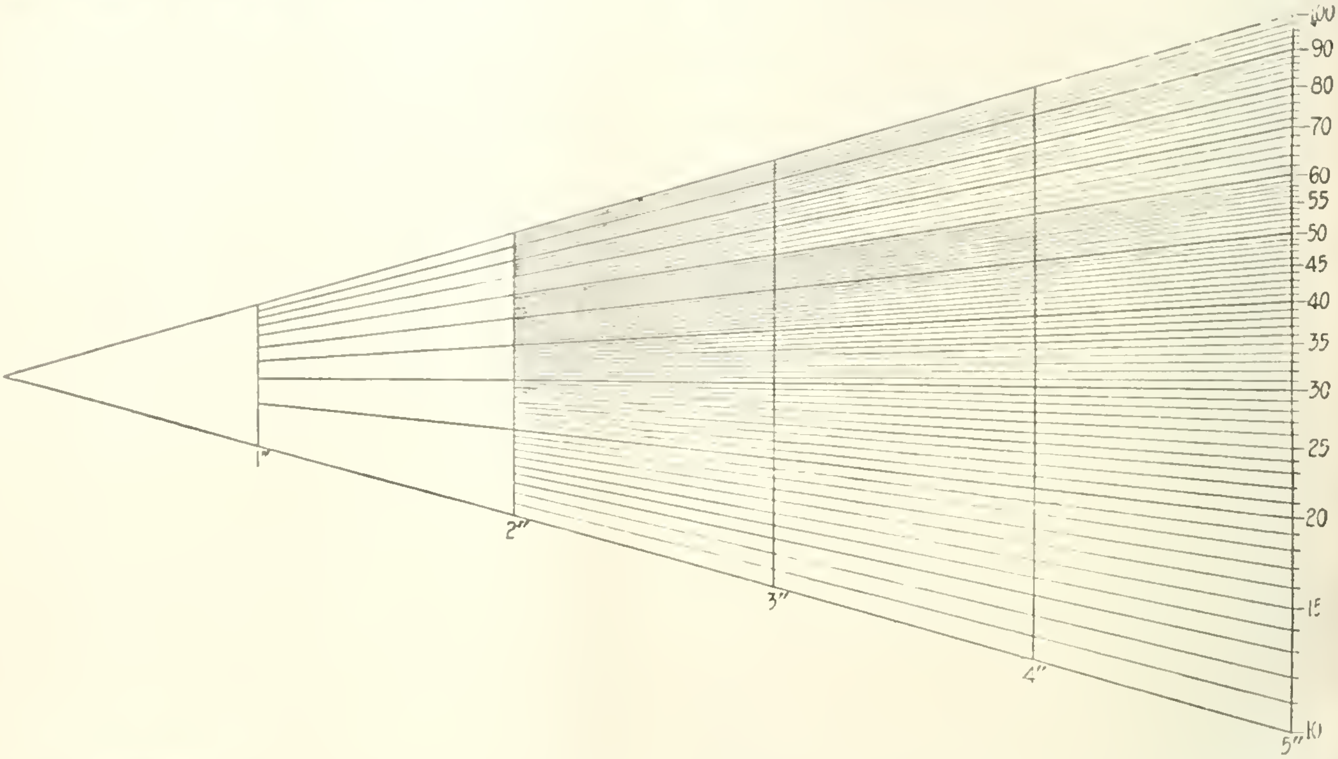


Fig. 2—Logarithmic Diagram.

Silicon Fuloride as Timber Preservatives.—The Philadelphia & Reading Coal & Iron Co. is now using a solution of a silver fluoride for treatment of its mine timbers. The pressure treatment is employed, about 0.3 lb. of silver fluoride being required per cubic foot of timber. The company, according to an article by Dever C. Ashmere of Wilkes-Barre, Pa., in the Coal Age, has found that the fluoride attacked the metal parts of the treating plant less vigorously than did zinc cloride and therefore reduced the cost of repairs. It also has a greater toxic effect on the timber treated.

New York City Regulations for Design of Reinforced Concrete Flat Slabs.—Our attention has been called to an error in our reprint of the new regulations of New York City for the design of reinforced concrete flat slabs in our July 28 issue. The third paragraph under the main heading, "A. Interior Panels," in the second column on page 98, should have read: In four-way systems, the negative moments shall be as specified for Two-Way Systems; the positive moment on the two outer sections shall be + 1/100 W L, and the positive moment on the inner section shall be + 1/100 W L for slab with drops; and the positive moment on the two outer sections shall + 1/71 W L, and the positive moment on the inner section shall be + 1/100 W L for slabs without drops.

Engineering and Construction Organization for Rapid Work*

By I. W. McConnell,
Vice President, Dwight P. Robinson & Co., Inc.

Every engineering enterprise or project [illegible] goes through some process resembling the following:

First. The conception or vision of the need.

Second. The preliminary studies to develop the general facts, including rough estimates of cost.

Third. The business consideration as to feasibility ending in rejection, or in postponement or in decision to proceed with the enterprise, or to investigate more thoroughly.

Fourth. The decision to proceed having been reached construction is ordered.

Advantages of Shortening Construction Period. Once the construction decision is made it is usually economical to push the construction work at the highest rate which physical limitations will permit. The value of speed may be gauged roughly from savings or gains to be made on three factors:

1. Carrying charges on the preliminary investment which preliminary investment frequently may be deferred either wholly or in part, to a later date if it is known that the construction period can be shortened. This investment will consist of real estate, franchises, permits, etc. In certain types of enterprises this portion of the investment may be as much as half of the total cost, and the saving may be proportionate.

2. Carrying charges on funds required for construction. This may be assumed for convenience as the interest on the construction cost for one-half the construction period at the rate paid for the money.

3. Operating revenue arising from the use of the facility will presumably start as soon as the construction work is completed. In some cases operating revenue begins partially prior to total completion; that is, as soon as usable portions are finished, as in the case of storage warehouses or office buildings. But whatever time any predetermined construction program can be shortened the corresponding operating revenue can be counted as clear gain.

Of these gains the first one is the least tangible and is not determinable in a definite way for the purposes of this discussion. Each case will be a law unto itself in this respect. It is real, however, and should not be regarded purely as a theoretical advantage.

The second gain is tangible and susceptible of accurate determination, e. g., a construction program requiring normally two years for completion and utilizing 6 per cent money would save in interest about 3 per cent on the construction cost if the construction program could be shortened to one year.

The third gain from operating revenue is the most tangible and usually the largest in amount.

Examples of Saving Effected by Shortening Construction Period. A great city office building is planned to cost $10,000,000. The real estate may cost $2,000,000, clearing the site $500,000, the structure $7,500,000. The building may have 600,000 sq. ft. of office space rentable as soon as completed at $2.50 per square foot per year. The money for the investment may be worth 6 per cent interest and a normal period for preparation of plans and completion of construction may be two years. If the work can be done in 18 months there will be a gain as follows:

Carrying charges for real estate [illegible] of $2,500,000, 6 months at 6% per annum	[illegible]
Interest on construction fund— $7,500,000 at 6%—¼ years	112,500
Operating revenue— 600,000 sq. ft. at $2.50 per year for [illegible]	[illegible]
Gross gain	[illegible]
Less operating expenses	[illegible]
Net gain	[illegible]

Of course, it must be recognized that no saving under item 1 can be counted on real estate purchases which must be made years in advance and held until the propitious time for building. Also if any actual gain in rentals is to be realized time gained on office buildings must bring completion at the local moving time. In New York, for example, the financial district moves on May 1st, the dry goods district moves on [illegible] 1st and the [illegible] district moves on October 1st. Leases must [illegible] be made for those dates and speed to [illegible] may not be justified.

Again we may look into the case of a steam power station to be built to supply a growing load and to replace loss of firm capacity in older plants. The capacity of the new plant is to be 70,000 kw., its cost estimated at [illegible]. Its annual output may be 240,000,000 kw-h. per year, of which 100,000,000 kw-h. may be load taken off the older plants at a net saving in generating cost of three-quarters of a mill per kw-h., and the balance may represent the growth in load sold at a net profit to the station of ½ ct. per kilowatt hour. The time for preparing plans and building such a station, under ordinary routine, might be 21 months. If the time from the date of the appropriation of money can be reduced to 1[illegible] months the savings may be considered as follows:

Carrying charges on real estate, franchises, etc.	Intangible
Interest on construction funds— [illegible] at 6% for 1½ months	$[illegible]
Production in nine months— [illegible] kw-h. @ ¾ mill	[illegible]
10[illegible] kw-h. @ 5 mills	[illegible]
Total gain	$[illegible]

The instances cited are hypothetical, but the points illustrated could, if necessary, be brought out much more strongly by citing actual cases of power plants, industrial plants, warehouses, stores, hotels, etc., where the savings could have been as great as in the examples.

It may be admitted, to eliminate argument, that rush work costs more than work carried on more deliberately. There is, of course, some rate of speed on every job which marks the limit of rational cost, but that rate is usually much higher than people imagine, and such losses as do occur legitimately are largely offset by reduced costs of the overhead and supervisory items of expense. There are many elements which enter into the costs and frequently the tendency is to load the sins of all upon the speed element.

Co-ordination Essential to Rapid Construction Progress. One of the most important elements in any construction program is that of co-ordinating the various portions to give logical progress without breaks in the continuity of operation or undue interference by the later items of the work with earlier ones. This implies control from start to finish of the supply of material and equipment to be built into the structures and of the labor and equipment necessary for the construction work at its various stages. The old-fashioned axiom of "a place for everything and everything in its place" is as good a general statement of the ideal as any other. Now all of the elements tend to go astray under any kind of speed programs, but they are more difficult to control under fast schedules than under slow ones.

Every city dweller knows the confusion and delay which follows an interruption to traffic at a busy street intersection. The same kind of confusion follows a break in a stream of production by the displacement of any of its elements. On construction work such a displacement might be the failure of gravel, sand or cement to arrive for the concrete gang; or the breakdown of a derrick or industrial railway, or the necessity to unload and store machinery which arrives ahead of its proper sequence and before a place is ready for it. The gangs immediately concerned are thrown out of step, so to speak, and their discomfiture affects contiguous gangs, frequently extending over the entire job.

In manufacturing establishments which turn out the same or similar products day after day there is an opportunity to control the flow of materials to a high degree. There is also a perfect opportunity to train workers in a repetition of the same task under identical conditions. This opportunity rarely exists to such a degree in construction work. Each job is a new problem, and in the main the personnel of the workers will change from job to job and on the same job. Notwithstanding such disadvantages, many opportunities exist for control and sound methods of procedure can be perpetuated and passed on from job to job by retaining as permanent associates the men who carry the principal engineering and construction responsibilities.

In discussing, therefore, the so-called excess cost of fast work a clear distinction should be drawn between failure to co-ordinate work properly as distinguished from the cost of speed. "Failure to co-ordinate" not covered by failures due to causes beyond control, becomes poor management. "Cost of speed" should be clearly foreseen and understood as a price payable for quicker results. It may be due to premiums for expedited manufacture of material or to higher wages for overtime; or for night work; or for quick deliveries of materials by unusual methods of transportation such as trucks instead of railroads; or to the use of higher-priced products available at once in lieu of waiting for routine deliveries of lower-priced materials. There is a legitimate cost for speed, but the desire for speed should not be made a cloak for all the vagaries and misfortunes of the job.

---

*Abstract of an Aldred Lecture presented before the Department of Engineering at Johns Hopkins University.

There may be many reasons for rush work on engineering enterprises aside from the savings or gains involved in the construction program. A steel mill, recently completed, estimates its profits in the present market for the first nine months of operation as sufficient to pay the cost of the mill. What would be the value of rapid construction under such conditions, particularly if the end of the nine months period promised a falling market on that class of products?

A steamship company may be in urgent need of new terminals and warehouses to expedite sailings or to insure performance on contracts on highly advantageous business. The value of speed in construction can hardly be measured in such cases. During 1919 a certain steamer making a round trip to the Caribbean about every eight weeks carried 2,000 tons of freight each way at any average rate of $12.50 per ton, and her passenger list brought in $25,000 per round trip. Thus her revenue earning capacity was not far from $75,000 per round trip, or about $1,500 per day, of which about one half was clear gain. This boat was old, slow and expensive to operate, but she lost three weeks on every round trip due to crowded conditions at New York terminals. Thus she lost in that year a total of 15 weeks, or nearly two round trips. If she were one of a fleet of 10 boats it is plain that speed in constructing terminal facilities would have been worth a fabulous price to the owners.

Method of Initiating Construction.—The routine method of initiating construction on a new facility is somewhat as follows:

Preliminary engineering studies are made as a basis for estimates of cost and for the necessary decisions as to final layout.

Complete engineering plans are prepared.

Tenders for the work are invited from contractors.

Contractors' proposals are received and examined, frequently resulting in changes in plan to meet necessary economies or to incorporate expanding ideas as to requirements. These changes may make it necessary to resubmit the plans to contractors for new bids.

The contract or contracts are let under plans and specifications which require the contractor to perform certain definite tasks at fixed prices and in fixed times.

This is the time-honored method, and the only one in a general way open to public officials to carry on their work. For this class of work it is perhaps as generally suitable as any other plan, and irrespective of suitability, it is the plan which must usually be followed until statutory requirements to that effect are changed.

The most significant date in a construction program is the date when construction work actually begins, for it marks the start from which all procedure must be laid down. Under the older method of contracting construction work the start cannot be safely made until the contractor is selected in a binding contract based upon a complete set of plans and specifications covering the generalities and the details of the work. Thus under this method the time to produce the needed facility divides itself normally into two periods, namely, the period of design and the period of construction, each of which for proper execution requires a reasonable amount of time, and neither of which can be cut much below a rational minimum without paying some penalty which may be too serious to contemplate. A frequent penalty of such attempts to reduce the time factor is failure to accomplish the end sought after paying a long price to get it. The construction end is, perhaps, more responsive to rush methods than the design, but even on that end of the work there will be some factor which will present an irreducible minimum which fixes the length of the job from the date when construction starts.

Now, any claim of savings based upon unusual speed in the construction end alone must depend for its realization upon ability to select a contractor who can beat customary records or upon ability to get together a new organization which can do it. The latter alternative has been tried so frequently, without success, that the effort is fairly well established as risky business. The former alternative has more promise of success, but is still a questionable device, quite as likely to bring disappointment as satisfaction.

Comparison of Fixed Price and Cost Plus Contracts.—The real opportunity to gain time lies in the simultaneous development of plans along with progress in construction. Let us illustrate by an example and set up a comparison of times under each of two methods.

The example cited will be that of a manufacturing plant on a new site opening up for the industry a new section of the country. The owner knows the profits of his business and judges the locality to be favorable as to raw material, factory workers and markets for the manufactured product. He decides to proceed. His new plant will consist of separate buildings—power stations, office building, main factory building, storage sheds and buildings for raw material, storage for manufactured products, trackage, roads, pavements and housing facilities for workmen. The owner has no careful estimate of the cost, but he knows in a general way what similar facilities have cost, and he judges that it will require an outlay of $3,000,000 and that his net operating income from the plant will be $50,000 per month. It must be practically all finished before operation can begin.

The owner requires:

A careful estimate of cost based upon sketch plans and inspection of the site.

Detail plans for construction.

Construction of the plant.

Let us assume that his own organization is busy and that he recognizes the advantages of employing specialists for special purposes. He knows competent engineers and contractors. He has many methods of procedure open, but one of two is commonly used.

Let us designate as Method No. 1 the method known as fixed price contract. Under it the owner has all plans prepared and approved, after which contracts are let upon the plans as prepared. Let us designate as Method No. 2 the method of carrying on the development of plans as the progress of construction work requires them. The following tabulation will show a comparison of the time elements entering into various phases of this work under a relatively high-speed program in the two cases:

Items.	Elapsed time from the date on which owner gives authority to proceed.			
	Method No. 1.		Method No. 2.	
	Time required. Weeks.	Accum. tot'l time. Weeks.	Time required. Weeks.	Accum. tot'l time. Weeks
Estimate of cost	2	2	2	2
Preparation of plans	12	14	No time loss	
Request for bids	2	16		
Considerations of proposals..	2	18	2	4
Signature of contracts	2	20		
Construction	50	70	50	54

The result will be the following gains:

Interest on construction cost— $3,000,000 at 6% for 2 months	$ 30,000
Operating revenue— $50,000 per month for 4 months	200,000
Total	$230,000

The indication of 16 weeks' gain is not fictitious, for no time need be lost waiting for plans after the decision to proceed is reached except that necessary to select a contractor. Neither does the gain imply undue haste on plans or on construction. It does imply careful co-ordination, which in turn implies experienced and capable men. There will be no spare time for experiments or to break in new men. If a contractor can be had who can also prepare the plans there will be that additional concentration of responsibility which is desirable. Necessarily such a program must be carried on under some "cost plus" form of contract, which implies that the owner and his organization will co-operate in every possible way to expedite the work.

Once the contractor is selected he can begin at once to move his outfit to the job, to make provisions for bunk houses and commissary, if needed, to place contracts for construction equipment, material and supplies, to lay out roads, build tracks, shops, warehouses and sheds, and in general to get ready for the actual erection of structures. Working plans of the plant to be built are not necessary at this stage.

By the time the construction [illegible] is ready for foundation plans the plans can be ready and thereafter step by step—as the work advances the plans for the later work can come out ahead of the construction need. On such a program plans will not be fully complete very far ahead of the date of operation of the plant. Close cooperation between designers and constructors must be [illegible], to preserve an orderly and logical progress without breaks in the continuity.

Basis of Overall Supervision.—From the standpoint of overall supervision there are four documents which in my judgment give the essentials.

The first is the official estimate of cost. This should be in the owner's hands in some form from the start of the job. It should be accurate and include all items entering into the work. It should be under constant study and revision expanding in detail as the plans progress and orders for material and equipment are placed and costs become established. The last official estimate furnished when the job is done should be a fairly complete statement of the actual cost of the work.

The serial document is the progress sheet.

The third document is the working schedule. It serves two purposes. In the first place it should be made up for any particular job from bogey sheets, which carry the name of every kind of item entering into that kind of job. This serves as a reminder to the compiler and insures measurably against omissions of sufficient consequence to break up progress. In the second place, its principal function is to assign definite responsibility for performance on every item entering into the work. By following it up from time to time with the necessary revisions a production clerk can call attention to lagging items and make such revision as may be required.

The fourth document is the organization chart for the job. This will indicate at any time the general scope of the work as of that date and the changing assignments will indicate to a practiced eye the progress of the job.

These four documents are the basis of overall supervision. When such a job is secured the first thing done is to assign the principal men to the various tasks involved. A general conference on requirements gives each principal man the cue as to how to proceed. One man is made sponsor for the engineering end and to him falls the task of laying out the production schedule for plans, of keeping in touch with all phases of the design and taking such steps as may be necessary to bring up lagging sections, to straighten out conflicts and in general to keep the development of the design end in logical order. Another man goes to the field with full authority as construction superintendent and takes up the preliminary tasks connected with his other work, engineering layouts, construction equipment, transportation, labor, accommodations for workmen, sanitary requirements, police regulations, flood protection, and the thousand and one details which enter into such work. Responsibility for purchases must be located and clearly understood. It is a sign of bad luck to come to the day to begin to build concrete forms and find, for example, that no one has bought wire for wiring them, and that there is none to be had for two weeks. Purchases must be expedited, failure to perform must be forestalled, shifts and expedients must be invented to get out of tight holes, and all the time the plan for the future must be closely studied. Somehow or other human affairs appear never to run ahead of schedule except on the destructive side. I have never known a constructive effort to start spontaneously or to keep going at schedule rates unless it is pushed vigorously all the time.

Engineering construction is a business which is best done by those who give it study and long practice. Because no two jobs are ever exactly alike, it calls for constant and active ingenuity and energy. Since many of its problems require only common sense and executive ability, many people assume that the technical side is of small consequence and plunge into it to the detriment of themselves and all their clients. Like every other business in the world, it is handled best by those who work persistently and capably at it, and keep an experienced, continuing force in the organization.

Computing Reinforcing Steel in Dams and Retaining Walls

Proportioning of dams and retaining walls is facilitated by making direct use of expressions not only for the maximum and minimum stresses on any selected horizontal joint but also for the point of zero normal stress and for the total tension in the reinforcing steel on the tension face. Methods of deriving these expressions somewhat different from those usually employed are described by Mr. W. Cavan Taylor of the Winnipeg River Power Co., Ltd., Winnipeg, Man., in a recent issue of the Canadian Engineer. The methods follow:

Let the force W act at right angles to the plane or joint AB and at distance z from the center as shown in Fig. 1 (A). If the force were centrally applied, and the surface were one unit long, there would be a uniformly distributed stress over the whole surface of

$$p = W/l.$$

But since the load W is eccentric, the stress will be intensified at A and may be represented as $AC = p_1$. At B the stress will be smaller and may be represented by $BE = p_2$.

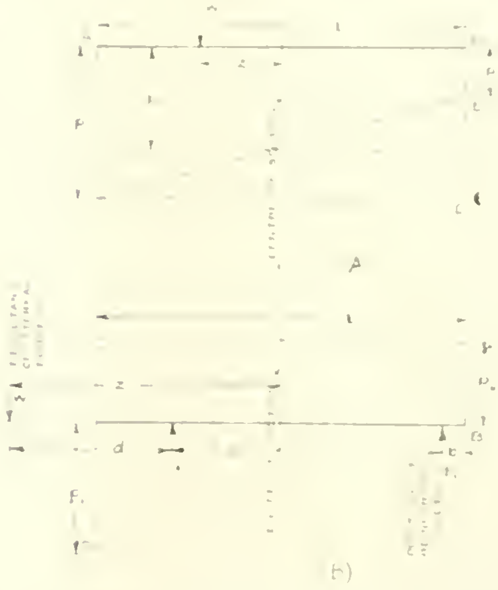


Fig. 1—External and Internal Forces Where Resultant Lies in or Outside of Joint.

Now the total upward force F reacting against W is represented by the area of the trapezoid ACEB and the line of action of this force F will pass through the center of gravity of ACEB. To equate the moment which this reacting force produces to the moment which the force W produces, it is advantageous to take moments about the center of gravity of the triangle CDE. By so doing the moment of the area ACEB (which really represents F) may be set down as the moment of the area ACDB, since the moment of the triangle CDE about its own center of gravity is zero. But the area ACDB = pl, and its moment about the center of gravity of the triangle CDE is pl × l/6. Hence

$$W \times (l/6 - z) = F \times l/6 = pl \times l/6,$$

and simplifying,

$$p_2 = W(1 - 6z/l)/l \quad \ldots\ldots\ldots(1)$$

Similarly,

$$p_1 = W(1 + 6z/l)/l \quad \ldots\ldots(2).$$

These two stresses p_1 and p_2 represent the maximum and the minimum stresses on the plane AB, or on the masonry joint represented by AB.

If the resultant W of the external forces falls outside the plane AB, as shown in Fig. 1(B), then p_2 becomes negative. The position of the neutral point C may be found from the geometrical relation,

$$AC : AB = p_1 : (p_1 - p_2)$$

But since AB = l,

$$AC = p_1 l/(p_1 - p_2) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3).$$

The forces acting on AC, Fig. 1(B), are represented by the area of the triangle ACD, or by their resultant F_1 acting through the center of gravity ⅓AC from A. The reacting or internal forces operating on AC and CB together hold in equilibrium the external forces, and the moment of the internal forces equals the moment of these external forces. The resultant internal force on CB, that is F_1, acting through any desired point on CB, such as the selected position of the reinforcing steel, may be found by taking moments about the center of gravity of ACD. Doing this,

$$Wd = F_1a$$

$$\text{and } F_1 = Wd/a.$$

If b is the depth of the steel from the surface, then $a = l - AC/3 - b$ and $d = z - l/2 + AC/3$. By substituting in the equation $F_1 = Wd/a$,

$$F_1 = W(z - l/2 + AC/3)/(l - AC/3 - b) \ldots\ldots(4)$$

But from (3) $AC/3 = p_2l/3(p_2 - p_1)$, from (1) $p_1 = W/l + 6Wz/l^2$, and from (2), $p_2 = W/l - 6Wz/l^2$. Substituting these values in (4) and simplifying, we have as the relation, giving F_1 the required tension in the steel,

$$F_1 = W(lz - l^2)/6z(5l - 6b) - l.$$

Knowing the safe tensile stress for the steel, the required area is readily computed.

August Building Operations

Building operations during the month of August showed a slight increase over July, according to statistics compiled by the F. W. Dodge Co. Contracts awarded during August in the 25 states comprising the northeastern quarter of the country amounted to $205,651,000, as against $204,398,000 for July. While this increase is not sufficient in itself to indicate an upward trend in construction activity, there are other factors which encourage the belief that the temporary slump is nearly over. The amount of contemplated work reported in August was $357,510,000, compared with $334,341,000 for July. This increase, in view of the enormous pressing demand for buildings of various classes, gives some indication of reawakened interest in carrying out the year's building program. An idea of the amount of deferred construction at present may be gained from the figures on contemplated projects reported by the F. W. Dodge Co. for the first eight months of the year, which have reached the sum of $3,601,451,000. Normally the amount of contracts awarded during the same period would amount to about two-thirds of the amount of work projected. Consequently, to preserve the normal proportion, contracts awarded for the eight months should amount to about $2,400,000,000 whereas the actual amount is $1,952,528,000, leaving a deficit of about $450,000,000 worth of construction. Contracts awarded in the first eight months of 1920, amounting to $1,952,528,000, compare most favorably with the amount for the same period in 1919, which was $1,596,311,000. The indications for the remainder of the year, according to the F. W. Dodge Co., are that succeeding months will show greater activity than has been in evidence during the summer months.

August Fabricating Shops Contracts. The records of the Bridge Builders & Structural Society, from reports collected by its Secretary, show that during the month of August, 1920, 72,200 tons of fabricated structural steel were contracted for throughout the United States, equivalent to 40 per cent of the entire capacity of the bridge and structural shops of the country.

Methods for Strengthening Old Wooden Truss Bridges

Useful suggestions, based on experiences in British Columbia, for strengthening old timber bridges, were given by Mr. T. Kilpatrick, Provincial Bridge Inspector, in a paper presented last spring at the convention of the District Engineers of the Province.

Figure 1 shows a method for temporarily strengthening a bottom chord with three sets of two rods each. Old truss rods can be utilized for this purpose. These can be put in quickly and will add much support until the necessary men and material are available to put in a more permanent method of strengthening.

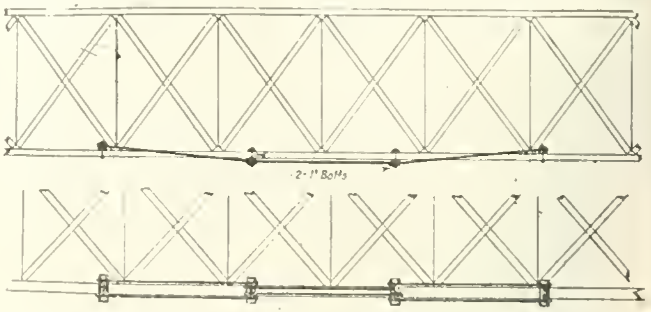


Fig. 1—Method for Temporarily Supporting Bottom Chord with Rods.

Figure 2 shows an effective method of strengthening bottom chords by reinforcing them with extra leaves on the sides. This plan shows a usual method of putting a reinforcing leaf on the outside and an extra clamp on any joint of the inside leaf that may have weakened. By this method the outside leaf can be put on with thick keys without interfering in any way with the bolts or rods of the old chord, except that it may be necessary to cut off the ends of some extra long chord bolts, and in some instances it may be found necessary to shorten some of the lateral braces to allow the extra inside clamps to be put on. If necessary, an extra leaf may be put on the inside, but this requires much more labor, necessitating a temporary system of lateral bracing and the shortening of the old braces. When doing this work care should be exercised in cutting the key seats in the old chord as far as possible from the clamps or packing of the old chord, and in the direction of the trestle stress.

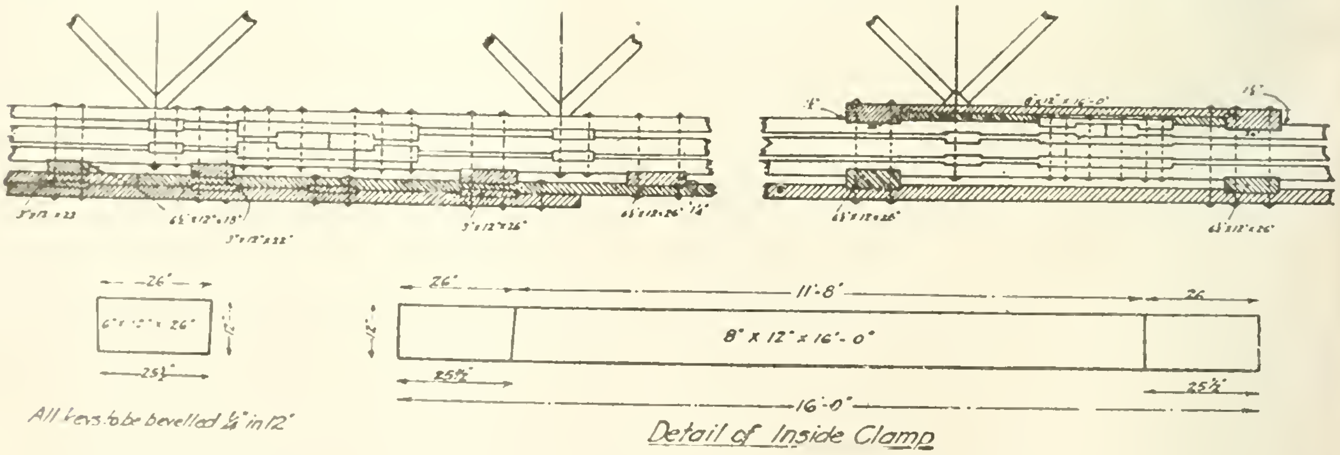


Fig. 2—Method for Strengthening Bottom Chord with Leaves.

Another method of putting on extra leaves is to frame them similarly to the leaves in the old chord, putting the keys directly opposite the old keys and clamps and replacing the old chord bolts and lateral rods with larger ones. This method will much increase the expense, and would not be suitable for old bridges with wooden clamps and packing, for where these are the chords are badly decayed, in most instances only a shell of good wood on the outside being left, and under these conditions it would be unwise to further weaken it by cutting away the outside surface.

A system of castings, bolts and rods can be used to directly connect a broken center leaf in a bottom chord. When the break occurs about the center of the upper four of the small castings with the necessary [illegible] rod may be used, but when the break occurs near the angle block it will be necessary to use two of the [illegible] castings on the top side to allow room for the connecting rod to pass over the angle block. By either method, [illegible] span, it will be necessary to notch the floor [illegible] the top rod. This will weaken the joists somewhat and it may be found necessary to put in extra ones.

Figure 3 shows a method of strengthening the lower end

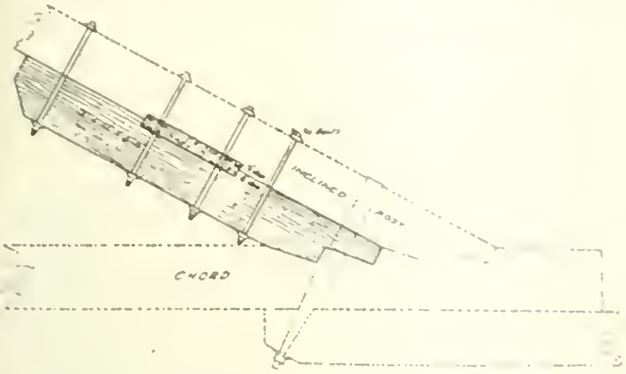


Fig. 3—Method of Strengthening Lower End of Inclineed Post and Bottom Chord of King and Queen Trusses.

of inclined post and bottom chord of king and queen trusses. This is a cheap and efficient method of strengthening the ends of these trusses where they invariably give way through decay. The foot of this additional post may be framed into one or two notches in the chord to suit conditions. If these are floor joists on the chord the ends of one or two of these will have to be cut off at the inside of the chord and the end supported by a piece bolted to the chord.

A method of supporting temporarily the upper end of a main brace when the angle block is completely crushed is shown in Fig. 4. One of these was put in at the top end of the second set of main braces of a 100-ft. span that had crushed 2 in. into a rotten angle block. This was done before high water this year and the bridge is still carrying traffic.

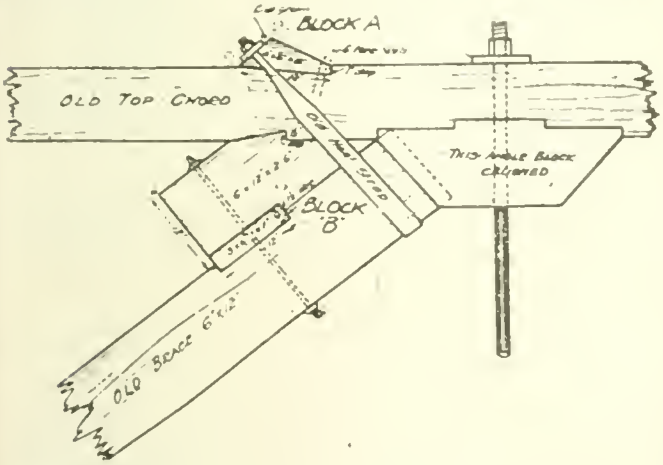


Fig 4—Method of Temporarily Supporting Main Brace When Angle Block Is Crushed.

Medium Size Office Buildings Bring Greater Returns.—In a recent address before the National Association of Building Owners on comparative investment values of office buildings, Mr Edward S. Jewell, of Omaha, recommended buildings of medium height to prospective investors. His principal reasons were: Fewer elevators, thus less waste of space. Lower buildings reduce fire risk, promote healthy conditions and prevent congestion. They are easily disposed of for good prices, while the large ones attract few buyers. A small building can be constructed for the cost of basements and sub-basements, elevators and shafts and other features of large buildings. A small building can be remodeled for a wholesale building in case the retail or financial district moves away from the chosen site in a few years.

The Contractor and the Architect*

By C. BLAKE JACKSON

[illegible]

Contracting and methods of handling contracts have been changing rapidly in recent years. The contractor of 20 years ago was, generally speaking, a comparatively rough type of individual whose business ability was measured by the forcefulness, fluency and loudness of his language, who was out to make all that he could and to whom character and reputation were negligible quantities. Today the modern, successful contractor has a reputation to maintain, a reputation for good workmanship, for integrity, for quick, efficient service—a reputation which means everything to himself and to the growth of his business, just as the architect's reputation means everything to him in his profession. The change is one which I know the architect himself is glad to note.

When steel buildings came into use requiring engineering ability together with the necessity of putting up a structure in a given time, it brought with it an entirely different type of contractor, a person whose qualification for success, besides having a practical knowledge of building construction, was organization ability as well as engineering training.

Upon the development of reinforced concrete, this change was even more marked, until today I know of no large city in the United States where work of importance is not let as a general contract to organizations known as "engineers and builders," "contracting engineers" or "general contractors."

Advantages of the General Contract.—Speaking purely as a member of the General Contractors' Association of Toronto, with which association I had the honor, last year, of being the first chairman, I would like to say a few words on the subject of general contracting.

In the first place, we find in most companies of this kind, organizations that are fully equipped to amalgamate all units of your building into one completely finished work. They employ trained engineers as well as the best practical men available, who have had special experience in the specific work to be constructed. I might mention here that in the General Contractors' Association of Toronto over 70 per cent of the executive heads of the firms are university graduates. I might also mention that the accounting systems today in most contractors' offices are equal to those in any other class of business and as much attention is paid to the purchasing department as is done by any manufacturing or commercial concern.

There is no doubt about the speed of the construction when the entire work is under the direction of one concern. You probably argue why cannot the architect secure the same results by acting in the same capacity as the general contractor? Experience has proved that this is an impossibility, for the reason that the architect has not the organization, the facilities for purchasing, the opportunity of rearranging the men or of pushing the sub-contractors; the latter knowing that if he falls down, the contractor will not hesitate to engage men in that particular trade and purchase materials to complete his work. The sub-contractor further knows that the contractor is responsible for the completion of the building in a specified time and it is a more essential part of his obligation to complete his work as his contract calls for.

At one stage in the life of the industry, now fortunately in the almost forgotten past, the attitude of the general public seemed to be that the contractor was in business for the purpose of putting something over somebody. In no other business or profession is it true that there is a buyer, a seller and a watch dog. An architect's place in the building world is to plan a building and see that the plan is executed; it should not be to watch for crooked work, to count the sacks of cement used and then accuse of intent. In many cases the builder is at the mercy of the architect's so called clerk of the works. Usually he has no knowledge of the building construction and spends most of his time checking the cement going into the mixer. I assure you it is a great joy to the contractor to have on the job an intelligent, practical representative of the architect, and if the owner or the architect cannot afford the services of such a man, it is better for all concerned to have none at all.

---

*From an address before the Ontario Association of Architects.

Clearly Defined Specifications and Standard Contract.—Contractors, unless they are familiar with the practice of the architect or engineer whose plans they are figuring on, are very often under a big disadvantage owing to the lack of specific details in the specifications. The specifications is a most important instrument and it is impossible to intelligently interpret the plans unless they state clearly and unmistakably what is expected to complete the contract to the satisfaction of the owner and the architect. Indefinite specifications and sketchy drawings are things to be abhorred; so many specifications are written even yet using such terms as "wood," "timber," "metal." Such terms are to be avoided. The lack of information in the specifications, and the different interpretations put upon that specification are also in many cases responsible for the great difference in the tenders of the various contractors figuring on the same job.

This is manifestly unfair to the contractor as well as to the owner and is indeed discrimination in favor of the contractor who has previously completed work from the plans and under the supervision of the architect and is familiar with his practice and standards. Every job has its individual characteristics, and the difficulties to be contended with are seldom, if ever, twice alike. Unfortunately, with some architects it seems to have become the practice to use a stock specification with but slight additions or variations for every job. The opinion of inspectors as to what constitutes a workmanlike piece of work varies with their experience, the contractor is very often at the mercy of an impracticable inspector or where the supervision is limited to the occasional visits of the architect, the owner is at the mercy of an unscrupulous contractor.

Any reputable contractor welcomes an intelligent inspection of the work in progress; it is of great assistance to his building superintendent and avoids costly errors. A clearly defined specification with sufficient details is of the greatest value in avoiding mistakes and enables the contractor to turn over to a satisfied owner a piece of work that will enhance his reputation and result in increased business.

It is to be regretted that we still have with us forms of contract which are obsolete, as far as the observance is concerned, but which many contractors are still asked to sign. Clauses which read, "that the architect's decision is final and binding on both parties without appeal," that "all work shown on the plans and specifications is to be carried out by the contractor, as well as everything else not shown on the plans and specifications, but what the architect may deem advisable to go into the work." Such clauses are all nonsense. They are never lived up to and should be deleted entirely to give us a modern working form of contract.

The construction business is one full of risks, financially and otherwise, and in days gone by the architect's sole endeavor seemed to have been to throw every risk without exception on the shoulders of the contractor. The Associated General Contractors of America have been working steadily on this phase of the situation, and a few months ago brought in a report which makes very interesting reading.

At this meeting it was pointed out that contracting was more or less a gamble, but many have not realized how much of a gamble until someone analyzed the income tax returns and made the following discoveries: The amount of loss for every dollar of profit made by construction corporations, and this includes building construction, is eight times as great as it is in manufacturing, agriculture or personal service corporations, five times as great as in transportation and public utility corporations, more than three times as great as in mining and quarrying, and nearly twice as great as in banking.

If the contractor could carry out a contract where his financial risk was reduced to a minimum, it would go a long way to reduce the high cost of building.

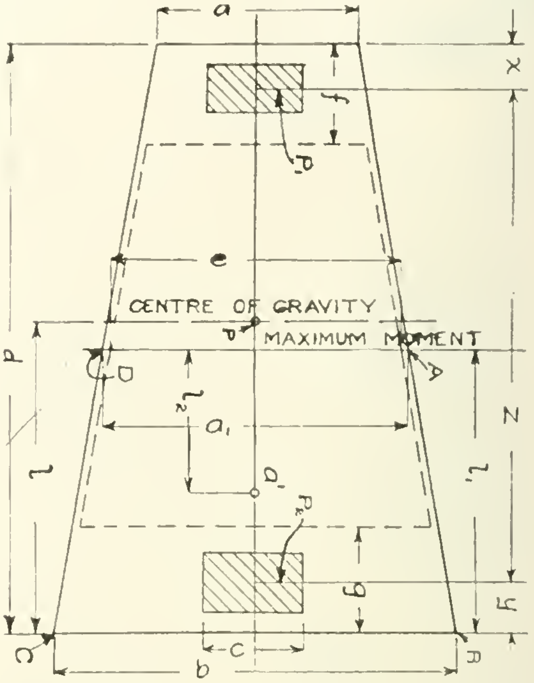
A. A. E. to Vote on Increasing Dues. The Board of Directors of A. A. E. has authorized a chapter referendum on increased proportion of receipts to chapters, effective September 1, and an increase in dues, except to students, to $15, effective on Jan. 1. The call for this referendum was issued on Sept. 15.

Convention of Railway Bridge and Building Association.—The American Railway Bridge and Building Association has changed the date of its annual convention from Oct. 19-21 to Oct. 26-28. It will be held, as originally planned, at Atlanta, Ga.

A Method of Computing Combined Footings

A method of computing combined footings which has been found to possess the merits of directness and ease of application is described by Mr. N. E. Helff in a recent issue of The Canadian Engineer. The method follows.

It is assumed that the column load P_2 is approximately twice P_1, and that any kind of column, preferably concrete, is used. It is assumed that the stresses and methods of taking care of reinforcing will be governed by the recommendations of the Joint Committee. The footing is assumed as not projecting beyond the columns in the direction "d" far enough to produce more than 40 lb. per square inch tension in the concrete due to bending if figured by the formula, $f = My/I$.



A = area of footing required,
s = allowable soil pressure per square foot,
F = weight of footing.

To establish the size and plan shape, the following formulas may be used:

$l = P_1(y + z) + P_2(y) \div P_1 + P_2$,
$A = (P_1 + P_2 + F) \div s$,
$a = 2A/d(3l/d - 1)$,
$b = 2A/d[1 - (3l/d)]$.

Thus all dimensions required are given.

The point of maximum moment, which is at the point of zero shear, is found in the following manner:

Solve for l_1 in $[bl_1 - (b - a)l_1^2/2d]s = P_2$ (Hool) which when simplified should give a quadratic equation of the form $ml_1^2 + nl_1 + q = 0$, and solving this for the smaller factor by the formula, $l_1 = n \pm (n^2 - 4mq)^{1/2}/2m$. This will give the distance of the point of maximum moment from the edge b.

The next step is the finding of the center of gravity a^1 of the trapezoid, ABCD, with respect to the side a_1 or $l_2 = (l_1 + 2b)/3(a_1 + b)$, after which the maximum moment can be figured in in.-lb. by the following formula:

$$M = P_2(l_1 - y - l_2) \times 12 \text{ (Hool)},$$

this giving the moment for band e steel, and depth calculations.

After this the footing must be examined for diagonal tension, punching shear and bond. Transverse reinforcement bands f and g must also be established. The moment for these is calculated by $M = 3P_2(b - c)^2/2b \times$ in.-lb.

Colored Plasters. The U. S. Bureau of Standards has completed its investigation of colored plaster and has found it possible to make colored wall plasters of any desired color or texture by use of dyed wool fiber in gypsum plaster. Panels of this material have been submitted to the Gypsum Industries Association in Chicago, and a publication on the subject is now being prepared.

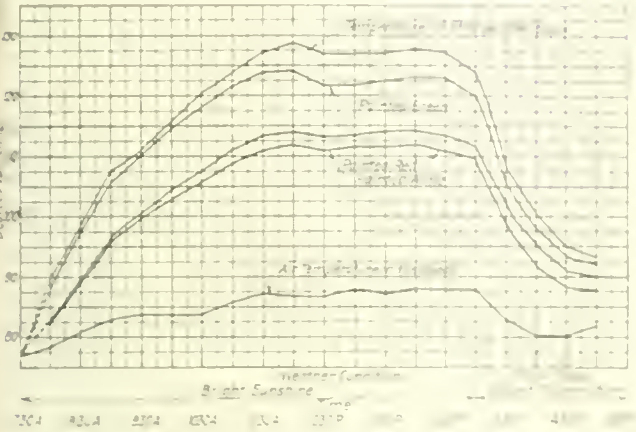
Effect of Color of Paint on Heat Absorption

By R. Z. KIRKPATRICK

Chief Hydrographer [illegible]

In April, 1920, experiments were made at Balboa Heights, Panama Canal Zone, to determine the amount of heat absorption due to different colors of paint. April was chosen because, in the latitude of the Canal Zone [illegible] and 9° north of the Equator, the sun's rays are then [illegible] nearly vertical at noon.

A hole, ½ in. in diameter, was drilled [illegible] deep into the side of each of 4 bars, each 2 in. x 2 in. x 12 in. long. The bars were then treated to one coat of paint, each of a different color. The colors used were white, red, green and black. Mercury was then put into the holes and the bars laid on a pavement in such a way as to get excellent exposure to the sun's rays. Temperatures were taken at 15-minute intervals by immersing the bulb of a standard Fahrenheit thermometer into the mercury wells. The results are shown in the accompanying curves. A simultaneous air thermograph curve has been plotted also. The thermograph was located in a shaded place, with free air circulation.



Temperature of Steel Exposed to Sun's Rays.

The results clearly indicate that the amount of solar heat absorption is considerably influenced by the color of the bars. The white specimen was about 2°, 12° and 17° F. cooler than the red, green and black bars, respectively, at noon; and the white, red, green and black specimens were about 25°, 27°, 37°, and 42° F. respectively above the shade temperature of the air.

It is apparent that engineers and architects may well take cognizance of this phenomenon in designing steel structures or buildings with steel sidings or roofs. Allowance for expansion in steel bridges or girder spans should be liberal and based on sun temperature variations and the heat absorption, due to the color of paint to be used. (Ordinary Weather Bureau temperatures are shade temperatures with free air circulation.) A corrugated iron roof will be more comfortable to the occupants of the upper story, if unpainted. If painted, use white or red, not black. A water, oil, acid or gasoline tank will tend to lose more of its contents by evaporation if painted the usual color of black or some other dark shade.

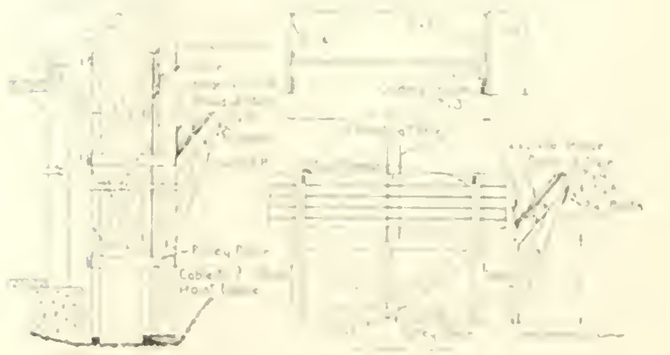
Heat absorption effects are measured about in inverse proportion to the degree of relative humidity for a given temperature of air. The Canal Zone has a high humidity in comparison with most places. It is likely that similar experiments in the United States in hot and arid localities would show greater variations than indicated in the curves. It is believed designers do not usually consider these things, but they are well worth consideration.

The Special Libraries' Association Committee on Methods—The Special Libraries' Association has recently appointed a special Committee on Methods to collect, with a view of publication, from all types of special libraries throughout the country, data in regard to various methods used in these types of libraries, such as subject headings, classification, cataloging, filing, circulating and routing literature, library publicity, forms of all kinds, purchasing, etc. The "special library" has been defined as a [illegible] collection of information either upon a specific subject or [illegible] of activity. It may consist of a small or large amount of material serving the interests of a special clientele, and preferably in charge of a specialist trained in the use and application of the particular material. The personnel of the committee includes the following members: Mary B. Day, Chairman, librarian, National Safety Council, 168 N. Michigan Ave., Chicago; Irene Warren, librarian, [illegible], Chicago; Frank K. Walter, librarian, General Motors Corp., Detroit; [illegible], librarian, Irving National Bank, New York; Daniel Handy, librarian, The Insurance Library Association of Boston. Data concerning methods used in special libraries should be sent to the chairman.

Hoist for Elevating Reinforcing Steel and Lumber in Building Construction

A useful hoist developed by the contractors was employed in the construction of a 5-story, [illegible]-ft. reinforced-concrete factory building at Johnson City, N. Y., for the Endicott Johnson Corporation. Steel for the first suspended floor was carried up a runway instead of being hoisted. For the remaining floors and the roof all reinforcing steel was hoisted to the proper floor on this hoist. In addition the hoist also was used for hoisting up form lumber, under flooring and sleepers. The device is described by Mr. [illegible], Construction Manager for Thompson & Binger, Inc., the contractors of the building, in the July Contractors' Atlas.

The hoist consists of a small tower with the horizontal side pieces extended to support a 2x12 and two pieces of 2x3 which form a groove in which the runners of the carrier slide. The runners of the carrier consist of 2x8's which form the sides of the carrier frame. Strap hinges are placed on the carrier, one end of which slides on the edge of the vertical 2x12. When the carrier reaches the top this portion of the hinge falls down releasing the bars from the carrier to the sloping 3x6's on top of the tower, the bars rolling or sliding on these to the floor of the building. Three flat iron bands placed on the platforms aid in the unloading.



Details of Hoist for Reinforcing Steel.

The pulley block on the carrier must be placed at a point on the carrier below the carrier platform so that when it is hoisted to a point near the top pulley block the carrier platform will have reached the top of the frame and will have automatically deposited its load.

The A. A. E. and the Federated American Engineering Societies

The following letter, in reference to the position of the American Association of Engineers relative to the Federated American Engineering Societies, has been sent to the joint conference committee.

September 11, 1920.

Mr. Richard L. Humphrey, Chairman,
Joint Conference Committee,
29 W. 39th Street, New York City.

Dear Mr. Humphrey:

Careful consideration was given by the Board of Directors of the American Association of Engineers at its meeting on September 11 to the invitation dated August 25 of the Joint Conference Committee to this Association to become a charter member of the Federated American Engineering Societies.

The American Association of Engineers, as expressed by its delegates at the organizing conference June 3 and 4, fully considered the idea of a Federated American Engineering Societies and Associations. It was then understood that as the purposes of A. A. E. and the F. A. E. S. are to deal with the non-technical activities of engineers there should be devised an effective system of co-operation in order to avoid overlapping and duplication of effort.

At the Washington conference the representatives of A. A. E. pointed out the fact that A. A. E. is already doing much of the work proposed for the F. A. E. S. and has in existence a successful "going concern" consisting of a central executive office, numerous subsidiary offices [illegible] and [illegible] some 125 chapters and [illegible]. These facilities were offered to the proposed federation. Having already in existence the organization necessary for its existence the American Association of Engineers cannot be expected to delegate to another body the trust that has been placed in it by [illegible] members to do their welfare work. It therefore seems to us that the effective method of co-operation between F. A. E. S. and A. A. E. will be for A. A. E. to be represented in F. A. S. E. as a co-operating member, A. A. E. doing its share of the work with its own organization at its own expense. Likewise, F. A. E. S. should be represented in the American Association of Engineers.

We shall therefore be glad to be represented at the November meeting and will designate a delegate upon our being advised that this plan meets with your approval. We will be glad to have you designate a delegate to the official meetings of A. A. E. and inform us of his name.

Cordially yours,

C. E. DRAYER, Secretary

Approved by the Board of Directors September 11, 1920.

Coatings for Preservation of Stone Surfaces.—At the request of the National Park Commission, the U. S. Bureau of Standards is making a study of various types of colorless surface treatments on stone for the prevention of disintegration by weathering. This question came up through the desire of the Park Commission to secure some form of protective treatment to aid in the preservation of ancient inscriptions on a large sandstone mesa at El Morro, New Mexico. The results of the investigation will undoubtedly be of more general interest, however, as all types of stone suffer more or less decay upon exposure to the weather, and a surface treatment which will not mar the appearance of the stone and yet prove to be fairly durable would be of great value.

Tests of Aged Cements in Concrete Mixtures. Owing to a shortage of cement in the District of Columbia for use on construction work being carried out by the Engineer Corps of the Army, the U. S. Bureau of Standards was asked to determine the strength of concrete made up from cement which had been in storage for about a year and a half. The cement as received was first put through a sieving process to remove the lumps. The cement after sieving, as well as the crushed lumps, were then made into separate concretes which were compared with concrete made from cement recently purchased in the local market. It was found that a 1:1¼:2½ mix of the old cement would give approximately the same strength as a 1:2:4 mix of fresh cement, and it was recommended that the lumps be sieved out of the old cement before using. Similar tests were conducted on aged cements submitted by the U. S. Engineer Office at Vicksburg, Miss. The results indicated that a 1:2¼:4½ mix of the aged cements gave approximately the same strength as a 1:3:6 mix of fresh cement.

News Letter

ST. LOUIS ITEMS.

By A. B. Koenig.

Thos. L. [illegible], Earlham, Iowa, can use a couple of team outfits on some new work on the Chicago & Northwestern R. R. in [illegible].

Mullen Bros., Alton, Ill., have about 5 miles of side borrow work to let on the Chicago & Alton R. R. between Roodhouse and Manchester, Ill.

Frank I. Bennett, director of the Illinois State Department of Public Works, Springfield, Ill., announced that the state will be ready to let contracts in October for the first work to be done on the Illinois waterway between Lockport on the Desplaines river and LaSalle on the Illinois river. An expenditure of $20,000,000 was authorized in an amendment to the state constitution in 1906.

Wm. Darklif has moved his 15-team outfit on to a part of Thos. L. [illegible], Jr., work on the Chicago & Northwestern R. R., near [illegible], Ill.

Jobst & Gates, Peoria, Ill., were low bidders for grading about one and one-third miles of the Mt. Vernon-Fairfield, Ill. highway. Their bid was $33,522.20.

The General Construction Co., Arcade Bldg., St. Louis, was awarded contract for erecting steel bridges in Wayne County, Ill., on the Mt. Vernon-Fairfield Highway.

Sanders Ward Const. Co. has [illegible] yards of short haul steam shovel work to let stripping bauxite at Bauxite, Ark.

E. Y. Sutherland, 217 Breman Ave., St. Louis, Mo., has a couple of good pile driver outfits idle.

P. L. Anderson has a drag line outfit idle at Sterling, Colo. Prefers ditch work. Is staying at the Great Western Hotel in Sterling.

Work will be resumed Monday on about 25 street projects here which had been discontinued more than a month ago because of the scarcity of cement.

McCauley Bros. were awarded the contract for building a reservoir for the C. B. & Q. R. R. at Vermont, Ill.

Tom Walsh and Dan Terry, of the Walsh Const. Co., were with us the other day. This company was awarded about 400,000 yards of steam shovel work by the Big Four R. R. Co. between Winchester and Farmland, Ind. Chas. Bresnecker will look after this job.

L. J. Viall has moved his steam shovel outfit on to the Frisco R. R., near Sleeper, Mo.

R. T. Amis & Son have a good size team outfit at work at the same place.

L. J. Smith Const. Co. were awarded another nice steam shovel job on the White River Division of the Missouri Pacific R. R. the other day.

P. E. Shugart has started grading the new yards for the Illinois Central R. R. at Clinton, Ill.

Contractors when in want of labor or work for their outfits, write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo.; 503 Delaware St., Kansas City, Mo.; 1020 Douglas St., Omaha, Neb.

Geo. Dameron is doing the grading for a creosoting plant at Leeds, Mo. Copeland Dameron, his youngest son, is bossing this job.

Walter Dameron, the oldest son of Geo. Dameron, has started a small team outfit on the Katy R. R. near Jennings, Okla.

Personals

Major F. P. Adams, for nine years City Engineer of Chatham, Ont., is now city engineer of Brantford, Ont.

Arthur Parker has resigned as city engineer of Cheyenne, Wyo., to accept the appointment of captain in the quartermaster's corps of the regular army.

Chester W. Davidson of Miami, Fla., has been appointed associate professor of architecture in the College of Engineering, University of Illinois.

Walter Cullen, city engineer of Dubuque, Ia., has been appointed building inspector and will carry on the duties of the office in connection with the city engineer's office.

Louis Brownlow has resigned as commissioner of the District of Columbia to accept the position of city engineer of Petersburg, Va., at a salary of $10,000 per year. Mr. Brownlow formerly was editor of a Paducah, Ky., newspaper.

Fiske Kimball has been elected president and L. B. Dutrow, secretary, of the Virginia state board for the examination and certification of architects, professional engineers and land surveyors. The members of the board are: P. B. Winfree, engineer of Lynchburg, one year; James F. MacTier, engineer of Roanoke, one year; John Kevan Peebles, architect of Norfolk, one year; Fiske Kimball, architect of the University of Virginia, two years; W. C. Noland, architect of Richmond, three years; Thomas M. Fendall, surveyor of Leesburg, four years; L. B. Dutrow, surveyor of Petersburg, five years; W. D. Tyler, engineer of Dante, six years, C. G. Massie of Amherst, seven years.

Industrial Notes

The Jeffrey Manufacturing Co., Columbus, O., has opened a new branch office in Buffalo, N. Y., at 1108 Marine Trust Bldg., which will be in charge of Mr. H. W. Scott, formerly of the home office.

The Blaw-Knox Co. will have an exhibit at the American Foundrymen's Association exhibition to be held Oct. 4th to 8th, inclusive, at the Ohio State Fair grounds, Columbus, O. The exhibition will consist of clam shell buckets, water cooled furnace appliances and prudential steel buildings. The booth will be No. 308.

Application has been made to U. S. patent office for an improvement on the Austin Cube Mixer drum. Strong claims are made on speed of mixing, loading and discharge. The new design is called the Cube-Hex and the mixing action is increased by the addition of six extra planes which throw the concrete across that thrown by the six side planes.

C. D. Mercer has been elected vice president in charge of sales for the W. H. Robertson Co., Pittsburgh, Pa. W. S. Tallman has been appointed vice president in charge of operations and will have charge of all factories of the company. D. W. Jasper has been appointed manager of the purchasing department, succeeding W. E. Coe, who resigned to go into the railway supply business.

In order to bring the value, adaptability and general advantages of metal lath more vividly to the minds of architects, builders, material dealers, etc. the Associated Metal Lath Manufacturers have had an educational movie made by the Rothacker Film Mfg. Co. This film will be sent to conventions of architects, builders and material dealers. It also will make the rounds of the technical colleges.

The employes of Blaw-Knox Co. recently received a very pleasant surprise when announcement was made that they had been provided with life insurance as an evidence of the company's appreciation of the value of loyalty, co-operation and continued service. All employes with not less than three months' service are insured for $500; those with the company from six months to one year, $750; from one to two years, $1,000; thereafter with each additional year's service the insurance is increased by $250 until a maximum of $2,000 is reached. New employes are entitled to participate in the benefits of the plan after three months' continuous employment.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Steel Buildings.—Blaw-Knox Co., Pittsburgh, Pa. 32-page catalog giving general idea of the design and construction of the Blaw-Knox Prudential steel buildings and their adaptability to various purposes.

Steel Buildings.—Truscon Steel Co., Youngstown, O. 48-page catalog illustrating and describing Truscon standard buildings. All the types of buildings available are shown, including buildings one, two, three and four bays wide, monitor types, sawtooth buildings, leantos, etc.

Sheet Metal Goods, Windows, Ventilators, Etc.—Willis Manufacturing Co., Galesburg, Ill. 168-page general catalog and price list of architectural sheet metal goods, underwriters' labeled metal windows, standard tin clad doors, ventilators, shutters and fixtures, and affiliated lines.

Foreign Engineering Review Quarterly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: 701 Woolworth Bldg., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
- (a) Roads
- (b) Streets
- (c) Street Cleaning
- (d) Municipal Miscellanies
- (e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
- (a) Waterworks
- (b) Sewers and Sanitation
- (c) Irrigation and Drainage
- (d) Power and Pumping
- (e) Management and Office System

Railways and Excavation—3rd Wednesday
- (a) Excavation
- (b) Management and Office System
- (c) Quarries and Pits
- (d) Steam Railways, Construction and Maintenance
- (e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
- (a) Buildings
- (b) Bridges
- (c) Harbor Structures
- (d) Miscellaneous Structures
- (e) Properties of Materials
- (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Volume LIV. CHICAGO, ILL., SEPTEMBER 29, 1920. Number 13.

English Road Problems

Editorial in Engineering, London, Aug 20 1920

It is a commonplace that the return of traffic to the roads, consequent on the introduction of the motor, found our highways incapable of withstanding the strain imposed on them, and demonstrated the necessity of extensive schemes of resurfacing and reconstruction. The rapid growth of road traffic during the past decade will now receive an additional impulse owing to the recent increase in railway rates and charges; and road costs are likely to be substantially increased accordingly. As a set-off to the burden thus threatening it may be observed that under present-day conditions, it is all to the good that the nation should have at its disposal alternative systems of transport. A monopoly under the control of capital can without difficulty be prevented from becoming unduly onerous, though some of the steps taken in this direction in the past have not in all cases been judicious. When, however, the control of a monopoly is assumed by organized labor, which is less amenable to regulation by law, there is a serious danger that the situation may be exploited to the injury of the public either in its corporate or private capacity. Indeed, we have already had instances of this, since although the railway companies are rightly and properly barred by law from discrimination between their customers, the employees' claim the right to refuse to handle goods addressed to unpopular firms. No doubt some remedy for such an abuse of power will ultimately be found, but in the meantime the difficulties arising from such a denial of "justice and right" can be much diminished by the further development of road traffic. Some instructive figures as to the value of this alternative means of transport were submitted by Major W. L. Gibson to the Dundee meeting of the Institution of Municipal and County Engineers. A traffic census taken under Major Gibson's direction showed that during the railway strike last year the road traffic over a certain section of the Great North Road in Perthshire was fully five fold the normal, and would undoubtedly have risen far beyond this figure had the strike continued.

The return of traffic to the roads and the consequent greater wear of the latter has been coincident with large increases in the cost both of materials and of labor. It is unlikely and in some cases undesirable that there shall be any substantial diminution in the rate of wages now paid to road men. Hence the sole prospect of keeping down road costs to a reasonable figure lies in the better utilization of the more highly paid labor. An interesting instance of what can be accomplished in this way was brought forward by Mr. James Lang, County Road Surveyor for the Kilmarnock District of Ayshire. He stated that good road metal was only half the price in America that it was here, although higher wages were paid in the States. This has been effected by the adoption of mechanical devices for handling the material at the quarry, and by the introduction of very massive crushing machinery. Some of these American machines had, it is stated, jaws measuring as much as 7 ft. by 6 ft. Such machines can break 500 tons per hour. An American plant of this type, but with a smaller crushing machine, having, however, jaws measuring 54 in. by 42 in., is he stated now being erected in Scotland, and is expected to effect substantial reductions in the present cost of road metal. Of course only a large undertaking can afford to provide itself with plant of this character, and many of our quarries are small. Matters, we believe, are even worse in France, where it has been the policy of the road authorities to give out all contracts locally, and for short periods of time. The result there has been that the contractors are small men with little capital and compelled, in view of their short term contracts for small supplies, to sink as little capital as possible in their undertakings.

Amongst other labor-saving schemes discussed at the meeting was the plan of conveying tarred stone in steel containers, each holding 25 cwt. These containers are to be carried to their destination by 5-ton steam wagons, fitted with a crane driven by gearing from the engine. It is admitted that the total weights to be handled will be increased by perhaps 20 per cent, but on the other hand there will be a great saving in the time taken to load and discharge. Hence it is maintained that the wagon will make easily six trips a day in conditions in which it is now difficult to secure four. Moreover the work of loading and unloading tarred stone by hand is far from popular, and there is some difficulty in getting men to undertake it.

In Major Gibson's paper already referred to particulars are given of a series of experiments made with different road materials on successive sections of the Great North Road at Dunblane. The length of road chosen was divided up into eight sections, which were surfaced as follows:

Section No. Character of Surface.

1. Ordinary macadam.
2. Ordinary macadam surface tarred.
3. Macadam grouted with pitch and [illegible]
4. Macadam grouted with pitch and [illegible]
5. Macadam grouted with tar and Trinidad bitumen epuré.
6. Tarred macadam, i. e., tarred material surface sealed distilled tar.
7. Tarred macadam, i. e., material tarred with two parts of tar and one of Trinidad asphalt epuré.
8. Tarred macadam, i. e., tarred material surface sealed with Mexican bituminous mixture.

The results observed with these different materials and methods of construction show that ordinary macadam as used for section No. 1 is entirely unsuitable for main road traffic. It cost 12.39d. per yard super to lay (pre-war prices) and [illegible]92d. per yard super to maintain for five years, but it was practically worn out in 4 years 9 months. Section No. 6 was the best of the lot and stood alone. It cost 20.72d. per yard super to lay (pre-war prices) and the cost of maintenance for five years was 11.56d. per yard super. It was tar painted in 1916, 1919 and 1920.

In a note on road rolling contributed by Mr. W. Ballantine, Road Surveyor for East Stirlingshire, highly favorable mention is made of the motor road roller, which is said to be specially well suited for use when roads are being resurfaced with tar macadam, which is a material that does not require heavy rolling. Amongst other advantages claimed for it is a saving of time in starting up in the morning, since with the engines in order a start should be made with one turn of the handle. The starting is in fact so easy that the engine should be stopped when the roller has to wait on the road. A supply of paraffin sufficient for two or three weeks can be carried in the covered van. With these rollers, moreover, provision is made for varying the load by ballasting one or both of the rolls. No insurance or inspection of boilers is required as with steam, and when the engine does wear out it can be replaced at less than the cost of fitting in a new firebox to its rival. In pre-war times with petrol at 1s. 3d. a gallon and paraffin at 8d. a gallon the running costs were much less than with steam, but at present prices, with petrol at 3s. 8d. a gallon and paraffin at 1s. 11d. a gallon, the fuel cost is about the same as it is with a steam roller using coal at 32s. a ton. On the other hand, the motor roller retains the advantage that its fuel involves less handling and that supplies sufficient for many days can be carried. Mr. Ballantine adds one word of warning in regard to the use of motor rollers. They must be kept on hard ground, as if a motor roller gets on to soft ground it has not sufficient reserve of power to extricate itself.

The Inarticulateness of Engineers

Editorial in The Engineer, London, July 30, 1920.

The advances of technical and scientific knowledge, and the ever increasing complexities of technological practice, have inevitably brought with them the development of a very large body of technical writing. One would like to dignify it by the name of technical literature, but for much of it that would be an entire misnomer. Unhappily, we find that most of those who write upon scientific or techncal matters are either unwilling or unable to clothe their facts and ideas in presentable language. Some, indeed, appear to revel in the use of crude and clumsy forms which leave the reader in difficulties. That this sort of thing is tolerated, and even encouraged by those who publish and buy books at their present very high cost can only be due to the fact that the readers of technical books papers and journals do not realize the kind of ill-treatment to which they are being subjected. It points, in fact, to an excessively low standard of literary education among those whose lives are devoted to technical matters, and this in turn points to a serious fault in our system of technical and scientific education.

The source of the comparative illiteracy of so many technical workers is undoubtedly to be sought in unduly early specialization of their education. In itself, it is undoubtedly surprising that men whose very business in life requires as an essential condition the power of clear and logical thinking and the exercise of mental faculties in a manner which is diametrically opposed to vagueness and crudity, should yet find it difficult or distasteful to express those mental processes in an equally clear and logical manner. Yet one has only to take up the average technical paper or book to find sentence after sentence in which it is quite evident that the writer has not meant what his written words at first sight convey, or that he has failed to make clear which of two or more possible interpretations is to be put upon his words.

No doubt the reason lies in an entirely insufficient attention to language, and failure to realize that the use of words requires not only care and thought but considerable training. It is by no means easy to express even comparatively simple technical matters clearly and concisely and in a manner which will leave the reader free to follow the written line of thought without having to struggle with obstacles arising from ambiguity or other faults of language. The student of a technical college or university, therefore, should not be left to find these things out for himself, for he certainly does not know them when he enters the college unless his previous training has been of quite an exceptional kind. If he has been permitted, for the later years of his school course, to specialize upon scientific and mathematical subjects which are "likely to be useful to him later," he has probably missed much of the purely literary training which boys following other lines of study obtain at the corresponding period of their education.

We would not by any means advocate a return to a largely classical education as the best preliminary training for scientific and technical workers, but it is painfully evident that the power of expressing themselves clearly and well in their own tongue, to say nothing of other languages, is often lacking in those whose knowledge and skill is great and valuable. Insistence on a certain degree of literary training and ability on the part of candidates for scientific and technological degrees in our colleges and universities would rapidly lead to an improvement which would react on educational methods in our schools and throughout the technical and scientific professions.

A considerable amount of technical "jargon" must unavoidably remain, nor need its use be regretted, even from the purely literary standpoint, but even technically specialized words can be used in a manner which is something better than a mere travesty of our language. It is true, of course, that if the facts and ideas which are dealt with in any piece of writing are sufficiently vluable, those interested will not hestitate to take the trouble to unravel even the most forbidding presentation, but the labor is often considerable, and much valuable matter undoubtedly remains buried beneath a clumsily erected pyramid of words. Much greater lucidity and ease of expression would serve to aid the advance of our technical and scientific activities to a very appreciable extent, and the remedy for our present inefficiencies in this respect is easy once the need is recognized.

Greater literary capacity in our engineers and technologists generally would, however, bring with it still other advantages. It would, for instance, serve to remove the stigma of comparative inarticulateness which is so often placed by the opponents of scientific education upon those who have specialized in scientific and technical directions. If it further made it possible for those whose work lies in other directions to understand and apprecate the work and the mental attitude of the scientific and technical worker, still greater good would result. Indeed, there is one aspect of this whole matter which is even now attaining serious importance. In any democratic community, it is of the utmost importance that any section or group should be capable of protecting its own interests and those interests of the community which are entrusted to it, by presenting its own case—when need arises—in a clear, convincing and forcible manner.

The trend of political events suggests that in the future this power of holding one's own will become of ever-increasing importance. Other groups of the community are becoming increasingly articulate, not to say vociferous, in support of their own claims or in defence of their rights. It is eminently important that those who receive scientific and technical training should not be left unfitted to present the interests of their own group in the press or on the platform. Yet at the present time, if we seek for examples of men of the scientific or technical professions who, when [illegible] have been able to take a strong part in public affairs [illegible] very few. Many causes, no doubt, are at work here, [illegible] the lack of the power of forcible and convincing [illegible] is surely an important factor.

A Standard Method of Measurement for Reinforced Concrete

Editorial from Concrete and [illegible]
[illegible]

A year before the war a joint committee representing the Quantity Surveyors' Association and the Concrete Institute met to consider some standardization of methods for measuring reinforced concrete work, and the report of the committee in the form of a 13 page pamphlet is now before us. Consisting of more than 40 members under the chairmanship of Mr. S. Bylander, this representative body submitted its proposals to the R. I. B. A., the Surveyors' Institution, the National Federation of Building Trades Employers and the Institute of Builders, whose suggestions were carefully considered. This report may, therefore, be regarded as representative of all the important interests concerned, and will doubtless form the basis for all quantity work on this subject in future. We need not occupy space in pointing out the necessity for uniformity in taking off reinforced concrete work. A unified system is long overdue, and a very valuable task has been accomplished. The report which has been approved both by the Concrete Institute and the Quantity Surveyors' Association, deals with both "in situ" and pre-cast work.

Beginning with some general instructions, it has been laid down that concrete formwork and steel reinforcement are to be billed together, for each section of the work, such as a story, and that the different materials are not to be separated under trades. This should greatly facilitate the adjustment of omissions and variations, since in such changes these three requirements necessarily stand or fall together.

The actual work is to be divided under the headings: foundations, struts, walls, beams, slabs, curved work, staircases, and pre-cast work. Work to be included under these headings is defined by reference, e.g., beams are instanced as main beams, secondary beams, braces and cantilevers. First the shape and size of these members is to be stated, then the quantities of concrete, formwork and steel necessary. [illegible] measurements are enjoined, the concrete in cubic feet, the formwork, super, the steel in pounds, and any special work, linear, super, or numbered, as most appropriate. As regards concrete, the contractor is to be informed that though proportions are given by volume the cement is to be put in by weight. This use of different units is a great weakness in our measurement systems, and is often not sufficiently emphasized in specifications. Volume and weight proportions are quite priceably different, and on a job the former method of measurement is alone practicable. On the other hand, transport companies invariably charge by weight, though merchants sell some national materials by volume. We think that it would be of great national assistance if some unification could be arrived at in this matter and commend the subject to the attention of those concerned. It is left to the contractor to add to formwork, which is measured super, the cost of overlaps, battens, strutting, fillets and the like, and we assume that the committee came to the conclusion that the factor for these additions is sufficiently constant to justify this omission on the part of the surveyors.

As regards steel, main bars ½ in. to 2 in., every size below ½ in., bars over 30 ft. long, stirrups and links, hooping, and meshwork, are to be kept separate. These items are to be described as fixed in position complete.

The report proceeds to describe particular items. For example, in the case of beams the shape and position, whether attached to pillars, relation of depth to width, whether main beams and if chamfered or curved, and so on, must be made clear.

The last four pages are devoted to pre-cast work. The time for execution is to be given in order that the number of moulds may be judged in repetition [illegible] and the necessary hoisting and fixing fully described. A further statement as to whether surfaces are left rough for plaster or finished to a fair face is required. For [illegible] work a short example of the quantities is given as a general guide to the method to be adopted. Finally piles are described in some detail. These are to be numbered after a full account of their construction [illegible].

In the early days of reinforced concrete work, specialists were so largely resorted to that the question of quantities was not a very urgent one. Now, however, so much work is designed without reference to any patent system that quantities have become a very important matter, and we feel sure that this report will be most welcome both to surveyors generally and to builders' estimators. It is terse and free from anything unnecessary to the object in view, and therefore will form a very useful and handy reference, and we feel sure that it should advance the use of concrete materially.

Standard Specifications and Research

Editorial in The Engineer, London, [illegible]

No one even moderately acquainted with the work which has been done by the Engineering Standard Committee—now the British Engineering Standards Association—can fail to appreciate the immense value of that work to British engineering and to the many great industries connected with it. British Standard Specifications have attained a status all their own, and the unremitting activities of the Standards Association and its numberless sub-committees may well be trusted to maintain that status. The one great objection to excessive "standardization" resides, of course, in the danger that once a "standard" has been adopted it tends to stereotype design and production, and to stifle progress and initiative. To a very considerable extent the practice of the Association meets this objection by bringing all its specifications up for revision at relatively short intervals of time, when they can be amended or withdrawn as may seem wise in the light of experience. Admirable as this principle undoubtedly is, yet it does not quite meet the real root of the difficulty. The specifications come up for revision it is true, but whence will come the initiative required to bring about revision? When new conditions have arisen which alter the demands of the user, or when other changes have affected the conditions of production, there will be a cause for revision, and those immediately affected may be trusted to bring either case forward. This is revision prompted, if not forced, from without, occurring as the result of the pressure of external causes. But it is not well to wait until one is pushed forward from outside, and we would therefore plead for an initiative towards progress from within the Association itself.

Whenever a committee or panel appointed to draft a new specification first comes together, discussion nearly always shows that the greatest obstacle to arriving at a really satisfactory specification lies in a lack of fundamental knowledge. It happens again and again that points of the highest importance have simply to be left "as they were" in some earlier specification, because no one is able to give definite data, or the point is settled on the strength of some expression of opinion which may be little more than the echo of works tradition or of local prejudice. Even in those cases in which fundamental facts are fairly well established, there is always a large number of outstanding points upon which a wide difference of opinion exists, not only as between users and makers, whose views often diverge as a result of their different outlook upon the same problem, but as between different makers of the same material or different users of the same article. This state of affairs is, of course, inevitable, since it is scarcely possible that our detailed exploration of the facts of nature should have kept pace with the rapid developments of our industries and technique, by methods largely of trial and error. "Practice" in this sense cannot avoid pushing far ahead of systematic knowledge. But it is none the less very important that we should do all we can to fill up these gaps in our knowledge and to provide as soon as may be systematic data to replace the more or less haphazard results of trial and error exploration. The work of the Association, in its many committees, provides one of the richest fields in this direction. There is, as a rule, a very frank interchange of opinions between the manufacturer and user, and the scientific investigator is often called in to assist in these deliberations. Often, indeed, he is able to solve some of the difficulties which arise; data obtained in a special investigation are circulated to the members of a committee, and, as a result a satisfactory conclusion is reached. But this result can only be arrived at when research work on the lines in question happen to have been carried out previously, or when it can, by some particular arrangement—as in the case of certain "aircraft committees"—be specially carried out for the committee. When such is the case, the results are often so important and so satisfactory that it may well be suggested that the consideration of the Main Committee of the Association should be given to this question of encouraging and even undertaking a much wider series of researches. The Association is already in receipt of financial support from the Government, but the money so derived is mainly required for the routine work of preparing and publishing standard specifications. A body possessing such wide-spread and influential support as the Association, however, should be well able to secure sufficient financial support from its technical and industrial subscribers to permit it to ask for increased grants from the Government for this very object of undertaking research.

We do not suggest that the Association should itself carry out researches, we do not feel satisfied that research either "by committee" or "by Association" is likely to be particularly successful. But if the Association had reasonable funds at its disposal for research purposes, the various committees would find no difficulty at all in having researches undertaken to clear up the many points of difficulty which constantly arise. Such work could be carried out at the National Physical Laboratory, which in the past has done a very large amount of work for the Engineering Standards Committee, and at various university laboratories which happen to be particularly suited for any given investigation. Research of this kind would be of very special value and importance for two reasons. In the first place, many of the questions which arise in discussions over specifications are of that "borderland" variety which do not appear to be the particular business of anyone. Some of these questions are not in the least likely to be taken up by any Research Association of manufacturers, partly, perhaps, because any committee consisting of manufacturers alone would agree on the very point which becomes a contested issue where manufacturer and user meet. Research on such matters would assist in placing the whole industry on a sounder basis, and this result would nowhere be better secured than in the case of non-ferrous alloys, which constitute a region in which the widest differences of opinion are to be met. In the second place, and, as we regard it, the more important, the conduct of such researches, by or under the auspices of the Association, would furnish a most powerful and useful initiative for the periodical revision of standard specifications. Where at present this incentive to revision rests with someone who, for one reason or another, has found the existing specification unsatisfactory, a new impulse would be created. The publication of the report of a research carried out under the auspices of the Association itself could not be ignored; it would become automatically necessary to bring the standard specifications into line with the new data obtained unless on critical discussion those data could be either discredited or shown not to be in conflict with the clauses of the existing specifications. Were such a course to be adopted, we might feel sure that not only were we safe against any tendency for the activities of the Association to clog progress, but we might look to the Association itself as a very powerful force actively making for progress.

Municipal Street Railways of London Not a Success

Editorial in The Engineer, London, July 9, 1920.

Municipal enterprises of all kinds are small scale representations of nationalized industries; in them we may see the effects of bureaucracy and of the democratic vote, and may study, by contrasting them with private undertakings of a similar kind, the probable course of events in businesses conducted by the State. In London we have two great public services run in the municipal manner—the tramways by the County Council, and water supply by the Water Board. Both are in a desperate financial position. We have also two services managed by the State—Posts and Telephone; both, again, are short of money. On the other hand, we have the gas supply, electricity supply, motor omnibuses, and interurban railways controlled by private enterprises. They are all carried on with a degree of success that is commendable in these hard time. They succeed because they are conducted on business lines. They sell the commodities they provide at a profitable price, and in settling that price they look at the balance sheet instead of the register of votes. Furthermore, by the avoidance of extravagances which are inevitable in the cases of governments and municipalities, they are able to sell more cheaply than any public body does, and to make a reasonable profit at the same time. To take but a single example, it would be interesting to compare the printing expenses of the London County Council tramways with those of any private tramway company. The figures would astonish those who are not accustomed to the handling of printing accounts.

A large portion of this week's "agenda" of the London County Council was devoted to the tramways, which, as all Londoners knew, are in a precarious financial position. It is true that they nearly always have been in that position, but it has grown rapidly more acute, and in March last a special committee was appointed to examine the problems, particularly with regard to an increase of fares. This committee has not completed its work, but it has been moved to issue an interim report, because the position disclosed by its inquiries is so serious, and the estimated deficiency on the tramways has grown so rapidly, that something must be done at once. It is with this interim report that we purpose now to deal. To discuss the various figures would bore and probably confuse our readers, and in any case they are rather of detailed than of general interest. It is sufficient to say that there is no small probability that the deficiency for the current financial year will amount to more than one million pounds sterling, which is equivalent to a special county rate of sixpence farthing in the pound! Had any private undertaking been allowed to get itself into so parlous a state no words of condemnation would be strong enough for it; the County Council escapes because it is a public body run, ostensibly, for the public good. Put brutally, the London tramways are hopelessly bankrupt, and the best thing to do with them would be to sell them piecemeal to the highest bidders—as the Thames boats were sold in similar circumstances—or jettison them if no purchasers could be found, and allow private enterprise, run on business lines, to cater for the needs of the public. That common-sense but heroic course the County Council has not the courage to pursue. It looks to other methods, of which the first is the perfectly proper and legitimate increase of fares—which we are glad to observe the Council has adopted—and the second is the wholly improper and illegitimate method of killing competition.

A large portion of the report of the special committee is occupied by an attack on the advantages enjoyed by the motor omnibus and underground railways of London, and it is seriously suggested that the motor omnibus companies should be purchased by the Council and then let to private managements, the object being, of course, to secure a part of the profits on the omnibus lines and to maintain such control over them that they would not press heavily on the tottering tramways. We cannot imagine that the majority of Londoners would approve that action. What the people of London want is good transport facilities, and they are quite indifferent whether those facilities are owned by the County Council or not. The omnibuses suit them; they provide a rapid and convenient means of transport at a reasonable price. A disinterested municipal body would rejoice in their success. It would see that they were serving the city well, and would encourage them. The County Council takes the opposite line. It desires to rob the public of the facilities the motor omnibuses provide because they interfere with the success of the trams. It would like a monopoly of transports in London. It makes, through the special committee, the usual complaint that the tramways are burdened with road improvements from which the omnibuses escape. Of course they are: that is one of the expensive items of the tramway system and is a legitimate charge on that system. A gas company does not complain because its mains are more expensive to lay and maintain than electric mains. It puts that charge down on the contra side of the account and it gives up making gas if, after allowing for its costly mains, it cannot make a profit. The fact is that tramways are fast becoming an anachronism; the independent vehicle is better in every respect. Instead of continually increasing its commitments, the Council should be taking steps to discharge itself of an intolerable burden. It would be far, far better to give up the tramways and [illegible] rate to the legitimate municipal enterprise [illegible] improvement for the benefit of motor traffic than [illegible] a weak enterprise by choking successful [illegible].

The London County Council tramways have always been a crying example of the futility of municipal enterprise directed into wrong channels. They w[illegible] the idea of unifying control for the public [illegible] which could be turned to necessary [illegible] improvements. The unification of con[illegible] whole plan which the Council could not afford [illegible] have disappeared and left a deficit of one m[illegible]. New factors have arisen in the motor omnibus [illegible] count very seriously the value of [illegible] and the Council cannot tolerate the waste of [illegible] and endeavors, therefore, to bolster [illegible] which is out-dated. Had the tramways [illegible] in private management this quandry would never [illegible] the public. The management would have for[illegible] modified its policy in time, or failing [illegible] the unavoidable loss would have fallen on private purses. The struggle of the unfit with the fit, of the old with the new, is inevitable in all affairs run by municipalities or States. They oppose improvements and arrest progress because they cannot bear to see the expenditure they have made thrown to the winds, and they would kill opposition however good it might be, rather than acknowledge the deterioration of their [illegible] work.

Utilising the Power of the Tides

Editorial from Indian & Eastern Engineer [illegible]

This is another of the engineer's dreams of the past that appears likely to come true in the near future. The question of using the power of the tides has come up again and again, only to be rejected, usually on the ground that the very heavy outlay involved in the construction of reservoirs renders any such scheme uneconomical. Lord Kelvin examined the question some years before his death and came to that conclusion.

At the present time there are two distinct schemes before the public, one of which at least is in a fair way of realization.

One scheme that has been outlined by a private inventor, who has, we understand, shown its feasibility up to a certain point, provides for barges, or rafts, or something similar being moored in the tide way, with water turbines held on, in or under the vessel in such a manner that the in-flowing and out-flowing tide can pass through the turbines, and furnish power to be used in driving electric generators. It should perhaps, be noted, en passant, that the realization of what were dreams in the past has been rendered possible, in almost every case so far, by the development of electrical transmission of energy. It would have been almost useless to have tapped the Niagara, Snoqualmie, or Cauvery Falls, unless it had been practicable to transmit the power obtained from the water turbines to a distance from the Falls; and similarly it is the electrical transmission of energy that is going to enable the power of the tides to be used. Electrical apparatus can easily arrange to take advantage of the varying rate of flow of the tides to compensate for the variation in the rate, and to make use of all the power that can be obtained from the tides in any river. In the proposal mentioned above, in which turbines are carried on a barge, or other vessel, the generators could easily be arranged to run at varying speeds, with the varying flow of the tide, and, of course, there would be no difficulty whatever in making use of the upward flow and the downward flow in the same river. Probably electrical accumulators will have to be employed, placed in an accumulator house built for them on shore in the neighborhood of the barge, and the varying flow can be arranged to charge the accumulator automatically, the variations being compensated for, or an engineer in charge of the plant can quite easily follow the tide up and down, and adjust his currents and pressures in accordance.

In the other method, which is to have practical application we understand, in the Bay of Fundy, advantage is to be taken of two rivers running into the same estuary. Dams will close in both rivers, at their mouths, and a dam is to be provided connecting the reservoirs formed by the main dams in each river. The flow of water through sluice gates in the dams will be made to drive turbines coupled to generators, that will transmit the current to accumulators or to be directly used for power or lighting. The turbines are to be run upon the [illegible] of the two river reservoirs. One of them is to form a high level basin, the water flowing into it and out of it furnishing the major portion of the power; the other river is to form the low level basin, and is to receive a certain quantity of water from the high level basin, the flow of water from one basin to the other furnishing power, and water is to flow from the low level basin into the main estuary, again furnishing power. In this particular scheme, the power station is to be fixed on an auxiliary dam, and the top of the dam is to be used as a roadway, electric trams being run over it, but provision being made by locks in the usual way for ships going up into the river forming the high level basin and coming out of it again.

A modification of this scheme has been suggested by some Swiss engineers of Lausanne, which they claim will be more efficient and give a higher return of the actual power present in the tidal water. In their scheme, there are two artificial reservoirs, or presumably natural ones where there are two rivers flowing out to the same point, one is the principal reservoir, and the other an auxiliary. Dams shut in both reservoirs from the sea separately, and a dam separates the two reservoirs. The idea is that during flood tide the water is allowed to rise on the outside of the dam of the main reservoir for about two hours, and it is then allowed to flow through turbines into the main reservoir for four and a half hours. For the next hour and three-quarters, a portion of the water now stored in the main reservoir flows into the auxiliary reservoir, for the next four hours, the water flows out from the main reservoir to the sea, and for the remaining hour and three quarters, the auxiliary reservoir returns the water it received previously to the main reservoir. At each flow of water from the sea to the main reservoir, from the main reservoir to the sea; from the main reservoir to the auxiliary, and from the auxiliary back to the main reservoir, turbines are made to furnish power and to drive electric generators, the current being transmitted inland, or to charge accumulators, or in any other way that may seem desirable.

The weak point of the second scheme appears to be the probable cost of the reservoirs, except where nature has done the work. There is a further modification of the scheme, in which the main reservoir is divided into two, and further power is obtained, or perhaps it should be said a more equal rate of power, by causing the water to flow between the two portions of the main reservoir, and from the auxiliary reservoir to and from the sea.

Speculation and Hypothesis.

Editorial in The Engineer, London, Sept. 3, 1920

The conclusion of the address which Professor Eddington delivered to the British Association is a defense of hypothesis and an "apologia" for speculation. It is well to recognize clearly the difference between the two. Hypothesis is best defined as a "provisional explanation." It is something set up as a target of criticism. If it withstands all attacks, if the apparent exceptions by which it is put to proof are unable to overthrow it, then it ceases to be an hypothesis, it ceases to be provisional, it is accepted as a full explanation. Speculation, on the other hand, means "looking into with the eye of the mind." A scientific speculation is a kind of irresponsible hypothesis. "The disembodied principles of all arts and sciences float before the imagination in undefined profusion." It is very open to attack, and is essentially of the stuff that dreams are made of, and may ascend boldly into spheres that close, disciplined scientific thought dare not mount. By its freedom from all trammels it may justly be accounted when prudently used the greatest of all forms of thought. Newton's magnificent idea of universal gravitation was a speculation of the grandest kind, and one of the most fertile in the ambit of knowledge. The speculations which Professor Eddington and his fellow-physicists are now permitting themselves to exercise are perchance not less great. Newton brought the largest movements and the largest bodies within the compass of man's mind; modern physicists, Eddington, Soddy, Bragg, Lodge, Rutherford, are bringing the smallest atoms—the matter of atoms—and the smallest movements, possibly, too, the matter of all motion—into the same small space. Speculation is their magic spy-glass; hypothesis their matter-of-fact test bench.

But great and wonderful as are scientific speculation and hypothesis, they are not without grave dangers. Who shall say how much of the false knowledge in the world is due to speculation. The man or woman who allows his or her imagination to play pranks with facts, may misguide generations of men. The uncritical do not, cannot, examine. They accept on faith and, as lightly as you please will forget all the reservations with which a philosopher hems in a speculation, and put it into circulation as sterling fact. It is desirable, then, that thinkers should keep their speculations in the closets of their own minds, or at most reveal them only to those who can appreciate them at their real value. Against hypothesis the same argument might hold good. The way to the hell of scientists is paved with false hypotheses. But an hypothesis must be published to do its work in the world, and all we can ask is that scientists will not put hypotheses before the general public before they have been screened and riddled, vanned and purified, till little speculation remains in them, and there is a good probability that they will withstand the criticism they provoke. "It is rightly said," says Gustave le Bon, "that science is the daughter of experiment, but it is very rarely that experiment has not hypothesis for its guide. This last is the magic wand which evokes the known from the unknown, the real from the unreal, and gives a body to the most shadowy chimeras." Le Bon evidently does not differentiate clearly between hypothesis and speculation. The former, we take it, cannot be built without facts; the latter certainly may be. An hypothesis, we take it, is reached by combining certain known facts in a definite order with the object of determining if thereby certain phenomena can be explained. The nebular hypothesis, for example, was certainly not chimerical in its origin, and it is as near to pure speculation as any hypothesis may be. But Herschel built it up originally from certain facts, and it has been strengthened by the accretion of other facts. It is probable that it must for ever remain an hypothesis, a provisional explanation of the formation of worlds. But the bulk of hypotheses do not for long remain in an uncertain state; they are either confirmed and pass into the general mass of ascertained knowledge, or they are found wanting and are thrown on the scrap heap of wisdom. To defend them seems little more than an act of supererogation, for it can scarcely be denied that they are at the root, if not the root itself, of all advances in science. To quote again from le Bon: "To make hypotheses, to verify them by experiments, then to attempt to connect, by the aid of generalization, the facts discovered, represents the stages necessary for the building up of all our knowledge." This quotation and that given above are taken from the conclusion of "The Evolution of Matter"—translated by Legge from the third edition of that notable book, and published in 1907

An overweening desire to secure to themselves the fame of priority leads many scientists, chiefly young researchers, to throw at the world speculations long before they themselves have tested and tried them to the limit of available knowledge. They say to themselves: "We will put it up; if it is wrong, someone will knock it down." The principle is in general a pernicious one. Followed amongst fellow-scientists in the same sphere, it may do no harm and may conceivably do some good ;but it is far too dangerous to spread false doctrines amongst all and sundry. To some, they will stick, and the spread of exact knowledge be thereby delayed. Darwin pondered over his great theory for well-nigh a score of years before he gave it to the world. It would be well that others followed his example. It is better to litter the laboratory with discarded theories and speculations, as Faraday's laboratory was littered, than to publish a single false one "Hundreds of men," says Karl Pearson, in the "Grammar of Science," "have allowed their imagination to solve the universe, but the men who have contributed to our real understanding of natural phenomena have been those who were unstinting in their application of criticism to the product of their imagination It is such criticism which is the essence of the scientific use of the imagination, which is, indeed, the very life blood of science."

Water Supply and Sewers for Buenos Aires. The Argentine National Board of Sanitary Works has been authorized to proceed with the extension of the water supply and drainage in Buenos Aires, and to expend thereon a sum not exceeding $4,750,000.

British Municipal Electric Railways and Fares

Editorial from The Surveyor, London, Aug. 13, 1920.

Municipal tramway undertakings have been in an unfortunate position for many years past, and the outlook does not appear to improve. Even the most prosperous concerns have been very hard hit, chiefly owing to the war, but especially to the aftermath of inflated expenditure that has been caused by the war. At Liverpool, for example, the prospects of the city tramways appear to be of the gloomiest, if we are to judge by a statement made recently by the chairman of the Tramways Committee. The undertaking, it was explained, is a losing concern. The city engineer's estimate of the work to be done this year in repairing the track and carrying out the Pierhead scheme amounts to £318,000, while the amount to the credit of the renewal and depreciation account is only £282,000, showing a deficit of £25,900. The operating cost of the system today is 99½ per cent of the revenue, and it is obvious therefore, as the chairman added, that if further increases take place in the wages and material, the expenditure will be considerably more than the revenue, and the requirements of the renewal and depreciation fund, which were equal to 1s. on the rates, will still have to be met. In the circumstances there is much to be said in favor of the contention that the traveling public must pay for their rides. There may be, and probably there is, something to be said for the argument of a labor councillor, that some blame for the present position of affairs may be ascribed to the past policy of voting profits to the relief of the rates, but it seems futile to lay emphasis upon this at the present crisis, and it is anything but helpful to find this statement followed by the assertion that his party would not consent to the raising of the fares. Apart from the fact that the policy condemned is a thing of the past, there is no denying that such relief as was given to the rates was enjoyed by the whole community, irrespective of class, while there can be no question that at present large proportion of the revenue from the tramways is distributed among the working classes in the form of increased wages. In the circumstances it is little short of unreason to say, in effect, that fare must not be touched, especially in view of the probability that both wages and materials may cost more in the future.

The Art of Reading

Editorial in The Engineer, London, June 11, 1920.

Reading seems the easiest thing in the world to the normal educated man. But there is reading and reading, and it is not everyone who knows how to make the best use of the world's literature. Some take it in by their eyes, but it leaves no permanent impression on their brains or their intellects; others really absorb it, but cannot make use of it. Like food to some persons, it makes fat, but little or no brawn and muscle. Others again read, often enough with apparent carelessness, and derive the greatest benefit from their reading; their intellects are sharpened and their refinement increased. But besides reading there is another invaluable accomplishment associated with literature. It is the knowledge of books. Relatively few books are worth much study but a great many are worth slight knowledge. There was a well-known editor of a London daily paper who made a hobby of collecting acquaintances as others collect stamps or china. Apart from his intimate friends, he was sufficiently intimate with a great number of people to know their value to him when he was on the search for information. A similar relationship to books is invaluable. Some should be close and familiar friends, and others just acquaintances. Anything that will encourage reading of this kind is a step in a good direction, and we must heartily commend the ingenious scheme now being put into operation by the North-East Coast Institution. It is devised to develop the art of reading among the junior members, and if it is well administered should do a great deal of good by encouraging at one and the same time the true appreciation of books, the art of writing clear English, and the development of scientific knowledge. We shall await the first report on its operation with the greatest interest, and for the moment we heartily congratulate the Institution on having found something that is new and yet has higher merits than mere novelty.

Flushing Water Mains

Editorial in Municipal Engineering [illegible] London June [illegible]

A necessary feature of maintenance [illegible] which little has been written is the flushing of [illegible]. No matter how good a water may be, the [illegible] flushed sooner or later, in order to rid them of [illegible] organic matter. The nature of the contents [illegible] render flushing necessary will have, of course, [illegible] influence upon the method of conducting the work [illegible] every case there are certain general precautions which should be taken. Of first importance is it to have a [illegible] labor on the job, in order to be able to open the [illegible] in the event of an outbreak of fire. Flush gates [illegible] shut off at a greater rate than the sewer will receive the water in order that there may not be any backing up with consequent damage due to flooded cellars. In the case of a main over, say, 16 in. in diameter, a number of hydrants must be opened simultaneously in order thoroughly to flush, and attention must then be paid to the effect of the water on street pavements. Experience has indicated, too, that when there is considerable deposit to be washed out there may be some after clogging of meters. Outlying districts may be flushed during the day but town flushing is always best done at night in order to cause a minimum of inconvenience.

How Waves Are Formed in Asphalt Macadam

Editorial in Municipal Engineering, London, Aug. [illegible]

Numerous efforts have been made within the last dozen years to discover the cause of the formation of corrugations or waves in asphalt. Pages have been written and numerous papers have been read and followed by discussions on the subject without any practical result being reached. It is possible, as has been urged, that the inconclusiveness has been due in some considerable measure to the discussions being invariably confined to municipal engineers, who, with remarkably few exceptions, have a restricted acquaintance with the manufacture and laying of asphalt macadam, chiefly because asphalt is a foreign product and asphalt macadam is a type of paving which is of comparatively recent introduction into this country. The subject, it will be noticed, has been discussed in the correspondence columns of a number of recent issues, and we direct the attention of county, municipal and highway engineers to the letters, because they are written, we may without breach of confidence announce, by men whose long experience of the practical aspects of the question, as, indeed, the letters reveal, makes their opinions eminently trustworthy. A correspondent, in our issue of July 15th, expressed the opinion that considerable experience and skill are required to secure the proper temperature and the fluxing, of the bituminous materials. Another correspondent, in our issue of the 22nd ult., who has laid thousands of yards of asphalt macadam, asserts with confidence that corrugations are due to a number of causes, which he sets out; while still another correspondent,* in this issue, agrees that the reasons enunciated are "undoubtedly correct," and adds to them the highly important one of the character of the aggregate. Where the sand used is round instead of being angular and possessed of a rough surface, they have, he contends, an increased tendency to roll, and the asphalt paving is quickly affected by the run of the wheels, and from continuous observation of different classes of work, the materials and laying of which were equal in skill and attention, the rounded sand used as the aggregate was responsible for corrugations. "Material of a porous nature and angular, and possessing a roughened surface, gives with the matrix," he asserts, "a high power of resistance to the wheels, due regard with the use of such material being had to careful grading to the obtaining of a close and stable texture." These opinions, coming from men of long and practical experience, carry us much further towards a solution of the problem as to how corrugations in asphalt macadam are formed and how they may be obviated than any knowledge which was generally possessed, and we commend them to all county and municipal engineers, for asphalt macadam is a type of paving which will be developed, as it has been developed in the United States, to a remarkable extent.

---

*These letters are reprinted on page 327 [illegible] Engineering and Contracting.

Functions of Technical Schools

[illegible]

At the present moment when scientific and technical education is being much discussed and plans for their extension are in preparation, it is worth while to consider seriously what the functions of the various institutions, colleges and universities should be, and especially how their activities should dovetail into one another. We perceive a tendency for institutions that are essentially technical schools or colleges to assume almost the functions of a university, and conversely we find the older universities in their zeal for applied science taking up work that might perhaps be more fitly left to technical colleges. There is also a certain inclination towards amalgamation for mere "bigness" which we are not sure is always desirable in an educational institution.

These remarks are suggested by the fact that in Germany the functions of technical schools are now being much discussed. There the so-called "technical school" has perhaps reached its greatest development, Charlottenburg being, of course, famous for its size and equipment. We see that Professor Riedler, late professor of engineering at this institution, is dissatisfied with the present methods, and even goes so far as to indicate that a decay set in with the present century, that too much stress is laid on pure technique and encyclopaedic knowledge and too little importance attached to general scientific methods and principles.

We are inclined to think that this somewhat arid and soulless form of work had become characteristic of many German technical schools before the war. It is, perhaps, a natural consequence of the commercialization of science in a narrow sense and the modern tendency to "judge by results." We hope that the momentary stress laid on the material results of applied science, necessary as it may be to arouse the interest of the business man, will not go too far in this country.

The pure spirit of scientific research and the uncramped imaginative effort that gives, in the long run, the greatest benefits to humanity, does not thrive in a commercial atmosphere. We hope that this greatest work will be pursued at our leading universities, and that they will not be compelled to adjust their methods to the "payment by results" tendency. Even at those institutions which are admittedly mainly technical, and even industrial, there should be room for the humanizing element in education and not too much emphasis should be placed on the purely material side of science.

Destruction or Salvage of Refuse

Editorial in The Surveyor, London, Aug. 27, 1920

From the sanitary point of view the disposal of refuse by cremation has such obvious advantages that the adoption of any alternative can only be justified if it is equally hygienic in operation and at the same time more economical. The importance that is now being attached to salvage as an alternative to destruction originated substantially during the war and as a direct result of war conditions. The acute shortage of certain of the constituents of ordinary town refuse which were urgently required for purposes connected with the prosecution of the war led to the creation of a special organization for their recovery, without much reference to the question of cost. In existing circumstances, however, different considerations arise, and although we believe that in exceptional cases some profit is being made by a salvage department, it remains to be seen whether this would continue if local authorities generally were to enter the market. A correspondent suggests that, although the simple apparatus required to facilitate sorting and sifting is less expensive to install than a steam-raising destructor, the latter can still well hold its own as the more economical—and certainly as the more sanitary—method of refuse disposal. In this connection it must be remembered that a ton of refuse has a calorific value for steam raising equal to that of one-seventh of a ton of best steam coal, and this is no small matter with coal at its present price. Moreover, disposal of refuse by burning produces a hard clinker as a valuable by-product for which there ought to be a specially good market at the present time, as it can be used in economical house-building. There is evidently a good deal to be said on both sides of the present controversy, and it is highly desirable that experts should make up their minds speedily as to which of the rival processes is to be preferred from the point of view of economy and sanitary efficiency—or as to whether there is room for both.

Psychologists and Industry

Editorial in The Times Engineering Supplement, August, 1920.

The remarkable results obtained during the war through the application of psychological tests to the purpose of selecting men for jobs, following as they do on good results experienced in the United States from the use of such methods in the selection of men for industry, has directed well-deserved attention to the possibilities of experimental psychology in industry. The tendency of some recent literature has, however, been to indicate that psychologists are offering to do more than carry out and interpret the measurements of experimental psychology, the credentials of which, when applied to appropriate uses, must command the respect of all engineers who are acquainted with them. Psychologists are in effect claiming a similar competence in what may be called social psychology, without having as yet produced any intelligible evidence in support. Such claims are likely to injure both their authors and the industry they seek to serve. If psychologists put forward conclusions in industrial matters outside the scope of their own science, they become industrial quacks at least as much as engineers would be surgical quacks if they tried to direct the operations or orthopædic surgeons on the strength of known mechanical laws. Psychologists who are also medical men, though they do not need to be told the danger of quackery, may still have something to learn of the complexity of industry. They may not realize the caution that is required in interfering with its processes, any more than even an honest and intelligent quack may realize the dangers of interfering with the processes of the human body. A more immediate danger is that, even if their extra-psychological conclusions are ignored, the stigma of presumptuous quackery may discredit the exact psychological work that no men are likely to do as well as they. It is, therefore, of considerable consequence to industry to know what are the claims of psychology in industrial matters, and by what credentials these claims are supported.

Engineers and Civic Education

Editorial in The Times Engineering Supplement, August, 1920.

The influences to which engineers in common with other workers are subject include some that operate to pervert them from their own interests and those of their industry. No fact is recognized more clearly at the present time. The consequences have already contributed to swell the taxation of the community, and before long will be creating a huge unemployment. Yet little is being done to counteract the forces by which many of the more intelligent workers have been led astray. Young men of brains and ambition exist among engineers as among other classes. They hear persons of no better brains than their own, including members of Parliament and university professors, laying down the law on economic subjects, and are anxious to understand what is being said. The anxiety is as legitimate as it is natural; but instead of its being satisfied by the popular, accurate, and impartial exposition of sound economic doctrine, the duty has up to now been left mainly to the parasites of industry, who have their own political axes to grind. As with plague and malaria, these parasites inoculate their own disease into those whom they bite, and these spread infection into others who were healthy. The mischief comes from employing infected sources for the teaching of civic facts; and much would be done towards providing a remedy if those who are concerned to have an industry that abides by economic laws took the trouble to have the knowledge of those laws taught accurately and pleasantly just as doctors urge the teaching of the laws of physical health.

Municipal Dairies in England. One or two of the larger municipalities in the provinces are about to enter seriously into the milk supply industry. Sheffield Corporation has obtained powers enabling it to engage in the buying and selling of milk, while Manchester Corporation has decided to seek parliamentary powers to take over the wholesale and retail distribution of milk in the city. Sheffield is the first city in England and Wales to obtain parliamentary powers to engage in the industry, and in addition to buying and selling milk, the Corporation is enabled to make butter, cheese and dairy products, establish dairies, milk depots and milk shops, and also carry on dairy farms for the supply of milk to municipal institutions in the city.—Municipal Engineering.

The Murray River Improvement, Australia

From The Engineer, London, Aug. 20, 1920.

The locking of the river Murray and the construction of storages has been under consideration for many years, but the rights in the water of the river of the three states concerned, viz., New South Wales, Victoria, and South Australia, not being determined by law, and being in conflict in some respects, have prevented the adoption and execution of a definite plan of development by irrigation, and the preservation of the existing rights in navigation.

An Inter-State Conference of Engineers, appointed in 1911 to investigate the problems from an engineering standpoint, reported very fully on the possibilities and estimated cost of regulation by storage, a system of lockage, and the volume of water available for irrigation. As a result of the conclusions of this conference an agreement was drawn up by the governments of the three states directly concerned and the Federal Government, the latter undertaking to contribute £1,000,000 towards the cost of the whole of the works, the remainder to be borne equally by the three states.

This agreement which was ratified in 1915, but owing to the intervention of the war not proclaimed till January, 1917, provided for the construction of the following works in the three states:

(1) A system of storage at Cumberoona or some other suitable site or sites on the Upper River Murray to be approved of by the Commission (hereinafter referred to as the "Upper Murray Storage").

(2 A system of storage at Lake Victoria.

(3) The construction of weirs and locks in the course of the river Murray from its mouth to Echuca.

(4) The construction of weirs and locks in the course of the river Murrumbidgee from its junction with the river Murray to Hay or alternately at the absolute discretion of the Government of New South Wales, to be signified to the commission within one year from the date on which the agreement comes into effect, the construction of weirs and locks in the river Darling extending upstream from its junction with the river Murray and involving an equivalent amount of expenditure.

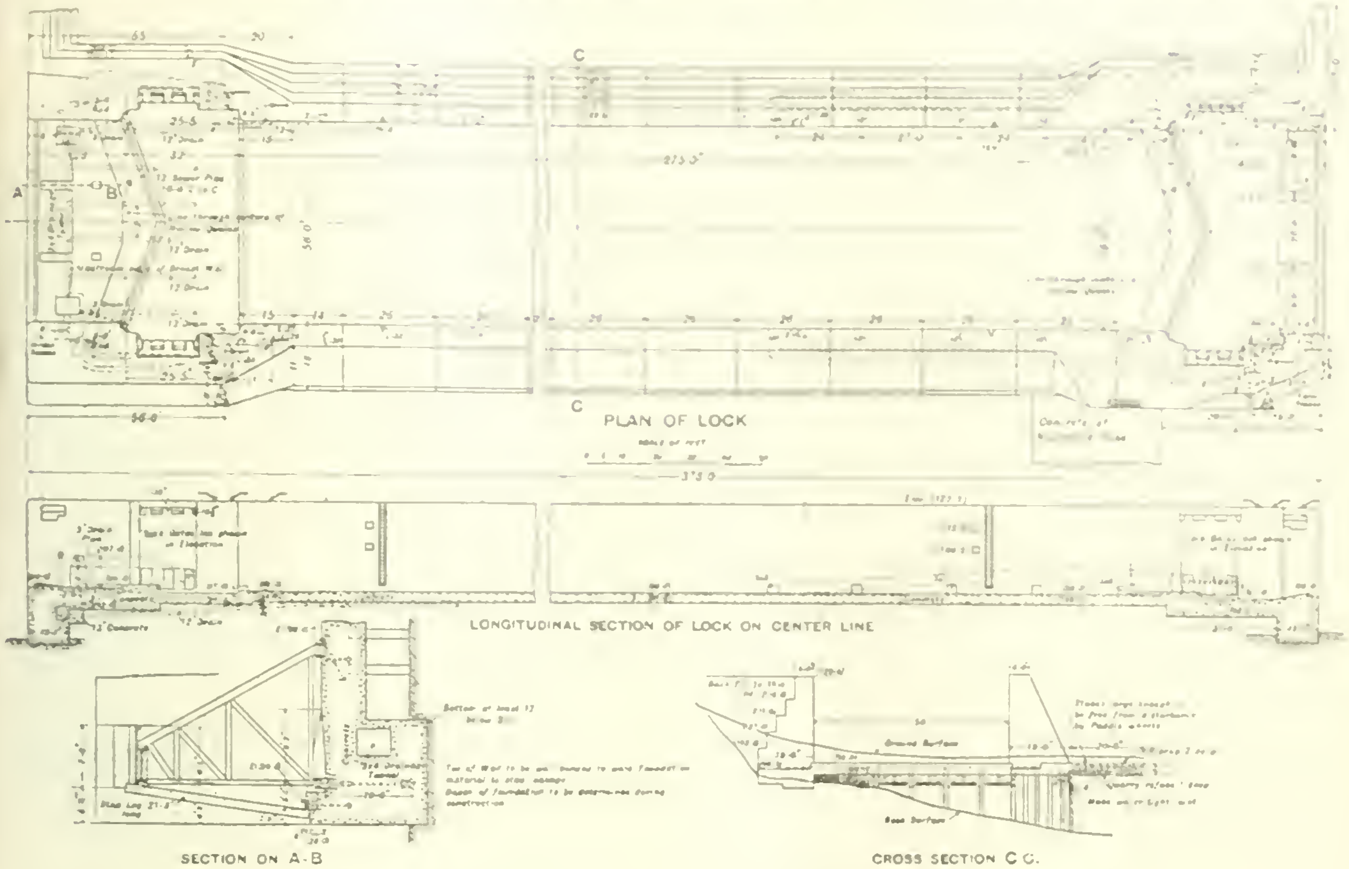
Of the above works the Lake Victoria Storage and the nine weirs and locks between it and Blanchetown, controlling about 350 miles of river channel, are to be constructed by the South Australian constructing authority.

During the progress of negotiations between the states for a settlement of the question, the Government of South Australia proceeded with the preliminary work of having complete surveys and designs prepared of the works in this territory, and in order to have advantage of the most recent experience in the design and construction of moveable weirs, engaged, by arrangement with the United States Government, Captain (now Colonel) E. N. Johnston, of the Corps of Engineers, United States army, who had large experience of similar works in America, to report on the scheme. His designs were adopted. The preliminary work had sufficiently advanced to enable the construction of the first of the locks from the down-stream end of the river to be begun in 1914. The work has been proceeding since that date under very adverse conditions, both as to supply of materials, abnormal flood conditions of the river, and industrial troubles, but it is hoped that the first lock will be completed and in operation by the end of the current year.

The rise of the river during floods is very gradual, seldom being more than 3 in. per day in the portion under notice, and ample warning of approaching floods makes the operation of movable weirs exceptionally easy. The surface grade of the water in the lower portion varies from 3 in. to 4 in. per mile, and the maximum surface flood velocity is less than 1 ft. per second.

The river flows in a valley of varying width, the bed of which consists of deposits of alluvium, overlying sand of varying depths. Under the sand in many places a soft marine sandstone rock is found at about 20 ft. below low water, and where possible this rock has been taken advantage of for foundations. In only one case, Lock No. 3, has it been found practicable to carry the whole of the foundations down to the rock, bearing piles being used in other situations. In two instances, viz., Nos. 5 and 7, the foundations are entirely in sand, the borings showing depth of over 100 ft. without change, but at the other sites as far as [illegible] a bottom of clay or sandstone has been obtained [illegible] the cut off piling can be driven.

The lock chamber as constructed [illegible] Blanchetown is 275 ft. long by 56 ft. in [illegible] to accommodate a towing vessel and two barges at [illegible] and although the question is not yet decided it is probable that this size will be adopted as far as the Darling River junction, a smaller size of 170 ft. by 56 ft. having been employed for the locks above this point. The river Wall is 18 ft. thick at the base and 6 ft. at the top, and the land wall is 16 ft. at base and 5 ft. at top. These walls were constructed in monoliths 40 ft. in length. The floor is 3 ft. in thickness, and reinforced with 1¼ in. twisted rods. A screen of sheet piling is driven on the upstream side of the lock and weir, and cribs of 10 by 10 jarrah filled with rip-rap are placed below the weir to prevent scouring. The filling and emptying of the lock chamber is done through sluices in the walls controlled by hand-operated butterfly valves. The capstans for the lock gates are also hand-operated.



Plan and Sections of Typical Lock for Murray River Improvement.

The act authorizing the works provides for a sufficient depth of water for navigation of vessels drawing 5 ft. of water. In the channel itself a depth of 6 ft. 6 in. is contemplated but the sill of the lock chamber has been kept at a level that will allow a depth of 9 ft. [illegible].

The weir within the limits of the navigable pass consists of Boule panels supported by steel trestles, hinged at the foot, which will lie flat on the concrete foundations when out of operation. There is usually only one high and one low period of the river during each year, and it will, therefore, very rarely be necessary to operate the movable parts more than once for raising and once for lowering each season. In some years after regulation is complete it will not be necessary to remove the weirs at all, as the whole flow will be under control by storage regulation. The sluice portion of the weir consists of concrete piers with timber stops which will be regulated in accordance with the volume of water passing down the river. When the flow reaches about 6,000 cusecs there is sufficient water to provide ordinary open river navigation, and the navigation pass will then be opened.

Lock and Navigable Pass in Course of Construction.

The work is being constructed within cofferdams, the first of which embraced the whole of the lock walls and navigation pass, and one bay of the concrete sluices, the balance of the work being enclosed in the second cofferdam. The cofferdam is made with two lines of sheeting 16 feet apart with earth filling between them and against each toe. The outer line of sheeting consists of 40 ft. by 38 lb. U. S. steel sheet piles driven into the bed of the river, and the inner line of ordinary timber sheeting, the two lines being tied together with iron rods. The height of the cofferdam at Blanchetown was about 20 ft. above the river bed, or 13 ft. above low water. During the excavation for foundations of the navigation pass the total head on the dam was 24 ft., but a remarkably small amount of leakage was experienced; 12 in. and 8 in. centrifugal pumps were provided for unwatering the dam.

A large quantity of plant was secured for the execution of this work, including: One radial traveling cableway 1,050 ft. span, capable of handling 10 tons; one 1½-yard dipper dredge, capable of digging to 20 ft.; two derrick boats, with boom-swinging gear, for operating clam shell and orange peel buckets; one steam towing boat, barges, dump-scows, derricks, a concrete mixer, air compressors, etc.; and similar plant is under order for other locks. A machine shop and woodworking shop are fitted with all the necessary machines driven by a 40 h. p. steam engine.

The nearest stone procurable for concrete is suitated near Mannum, about seventy miles downstream from Blanchetown, where a quarry has been opened up in excellent granite. The crushing plant has an output of 200 tons in eight hours, and the stone is loaded by conveyors direct into bin barges, which are towed to the works by a powerful stern wheel steamer built for the purpose. The sand required is dredged from the bottom of the river near the site of the work.

The Lake Victoria Storage, which is one of the two large storage works included in the Murray Waters agreement, is now in course of construction. Its purpose is to assist in the regulation of the waters of the Murray, and thus to supply water for navigation and irrigation within the State of South Australia when the natural flow in the river is not sufficient.

The capacity of the storage is 514,000 acre feet, or 22,500,000,000 cu. ft., the depth of water at full supply level being 24 ft. The works will consist of:

(a) The construction of about 25½ miles of embankment.

(b) The enlargement where necessary of Frenchman's Creek and the cutting of two inlet channels to provide an efficient inlet for the water. A controlling regulator will be placed at the inlet end of this channel, and a safety regulator near the lake to be used in case of a break in the line of embankment above it.

(c) An outlet regulator in the embankment facing the main storage to control the discharge from the storage. This regulator is situated where the embankment line crosses the Rufus River, which will act as an outlet channel and will be improved and enlarged to give a maximum discharge of 2,300 cu. sec.

(d) The necessary road diversions and bridges required in this connection.

The weir at No. 9 lock will serve to divert water into the storage. The cost of this work will be increased by the absence of suitable stone near the site, necessitating long transport by river.

A temporary regulator was erected in the Rufus River in 1915-16, giving a storage in Lake Victoria of about 110,000 acre feet for the purpose of ensuring as far as possible a supply for irrigation requirements in South Australia in the event of a repetition of the experience of 1914, when, owing to diversions by the upstream states, the river ceased to flow.

Marking French Highways.—That France is making systematic plans to make her roads intelligible. Under a new order all the villages in the country are to have their names shown in 8-in. letters. National roads will have red-painted milestones, while the old-fashioned signposts are to be replaced by large blue enamel plates, with the direction of the next town and its distance displayed in big white letters, so as to be readily read from the passing cars.

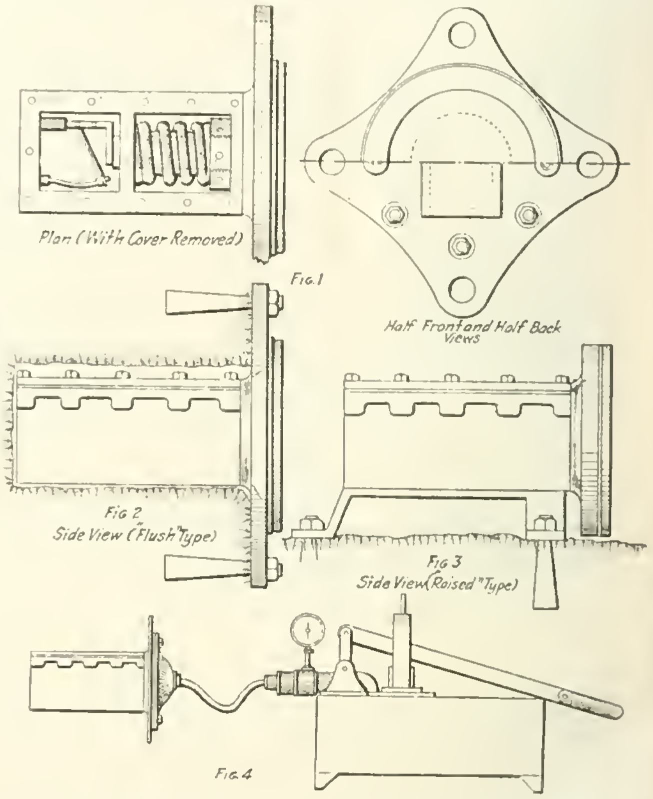
Action of Ocean Waves

By I. HIROI.

From the Journal of the College of Engineering, Tokio, Japan, June, 1919.

The author, in the course of his connections with harbor works for more than 20 years, has had occasions of making observations on wave-pressures that may be of some interest to those who are engaged in maritime works. The actual measurements of the force of waves carried out by him were mostly made at the Otaru Harbor and at Cape Taito.

Figure 1 shows the type of instrument that was used in greatest number. It is essentially a combination of diaphragm and spring dynamometers, and is made of brass, except the spring, which is of common steel. A disc about 3 in. in diameter, and backed by a spring of appropriate strength, is made to receive the stroke of waves. The compression of the spring is transmitted by the spindle—attached to the disc—to the multiplying lever, which moves the index on the graduated limb, and leaves it at the end of its greatest travel. The whole of this arrangement is encased in a brass case covered on top and made watertight by a rubber packing.


Plan (With Cover Removed)
Fig. 1
Half Front and Half Back Views
Fig 2
Side View ("Flush" Type)
Fig 3
Side View ("Raised" Type)
Fig. 4

Instrument for Measuring the Force of Waves.

The disc is covered with strong sheet rubber, tightly held down by a number of screws. For installing the instrument, either a cavity is prepared in the wall, with holding-down bolts planted around its mouth, as shown in Fig. 2. Rarely, however, it is set on the surface and anchored down as shown in Fig. 3. The calibration of the instrument is made by applying hydrostatic pressure on the disc, as shown in Fig. 4.

Another form of the instrument, one that should more properly be called a wave-dynamograph, has also been constructed and used with success. It records every wave-stroke on a revolving cylinder actuated by clockwork.

A number of dynamometers as above described were installed in groups at different points of the North Breakwater at Otaru, located 2,790 ft. from the root of the breakwater. The following tables give the results of observations made with these instruments:

Dynamometers.	Height in relation to sea level, feet.	Max. pressure, in lb. per sq. in., observed during three years, 1905-1908.
I	+ 2.4	50.0
II	— 1.8	17.6
III	— 7.8	14.3
IV	—10.8	10.0

The static pressure due to the depth of water below the mean sea level has, in each case, been deducted from the recorded pressure. It is to be noted that these maximums are not the registrations obtained at a time but are those taken out from the three following records:

Dynamometer	[illegible]	[illegible]	Year [illegible]
I	[illegible]	[illegible]	[illegible]
II	[illegible]	[illegible]	[illegible]
III	[illegible]	[illegible]	[illegible]
IV	[illegible]	[illegible]	[illegible]

These figures show, on the whole, a marked increase of pressure toward the water surface as would have been anticipated, but in some cases, reverse results were obtained as will be seen in the following tables:

Dynamometer	[illegible]	[illegible]	[illegible]
II	[illegible]	[illegible]	[illegible]
III	[illegible]	[illegible]	[illegible]
IV	[illegible]	[illegible]	[illegible]

Two important points are to be noted in these results of observations. It will be seen, in the first place, that the pressure exerted by a wave or waves is generally localized in its extent, so that the pressure of uniform intensity is limited to a comparatively small area. A pressure with mean intensity of about 30 lb. per square inch acting on the vertical surface 5 ft. above and below the dynamometer in a certain breakwater, or a uniform one of about 22 lb. per square inch on the whole of the exposed vertical surface would have been sufficient to cause sliding of the structure. Therefore it appears probable that the recorded maximum of 50 lb. per square inch had not acted on an extent much more than a limited area surrounding the dynamometer.

Another point to be noted is in the apparently anomalous records of the dynamometers. We know from the theory of wave motion, as well as from experience, that the force of a wave decreases rapidly from the surface toward the bottom. While most of the preceding records of observations are in accordance with this principle, there are several cases in which the lower dynamometers recorded greater pressures than in the higher ones during a storm.

An explanation for this apparent anomaly is in the fact that a wave often fails to deal its full blow on the object which it strikes. In dynamograph records, taken between June 5 and 15, 1907, there is but one maximum pressure recorded in the course of about 27 hours, during which no less than 10,000 strokes must have been delivered by the waves on the disc of the dynamograph. During a storm of a shorter duration, it is by no means unlikely that the instrument may fail to record any of the maximum.

This failure of waves to exert their full pressure at each stroke appears to be due to the nature common to impinging masses of water. That there is but one maximum among the results obtained from more than 90 well-directed strokes shows the rarity of full blows being delivered by impinging masses of water. Therefore, it is not to be wondered, when a great number of waves—generally irregular in motion when breaking—may totally fail to exert their force on obstacles, hence the discordant records often obtained by maximum recording dynamometers.

It should be noted that, in the dynamometer records already given, any one series of pressures under any stated date may not be—more likely they are not—due to the action of one and the same wave, so that these figures do not exactly express the variation of pressure exerted by a wave at different depths. As to the maximum pressure exerted by waves, that measured at the Rumoi Harbor is, in the experience of the author, the greatest, having amounted to 60 lb. per square inch. The highest pressure recorded at Otaru was 50 lb. per square inch. Most of the damages in detail, which could be done only by great force, were doubtless due to such pressure acting on comparatively small areas. But the force that affects the stability of a structure like a breakwater is the greatest mean pressure acting on the whole of exposed surface. This kind of pressure is far more difficult to observe than the one of maximum intensity, as it requires a large number of measurements by dynamographs installed at various depths.

These facts clearly show the futility of an attempt to find, by a few isolated observations, the probable wave action in a new locality.

There are many accounts of wave action in record, but they generally lack in necessary data for calculating the pressure. It would be highly useful, whenever opportunity offers, to make such observations as will enable one to base thereon the estimation of the wave-pressure exerted, and thus to make contributions to our knowledge with regard to the force of waves.

The foregoing discussions lead to the following conclusions:

1. The greatest pressure of [illegible] is found near to the water surface, acting on a comparatively small area.
2. A wave dynamometer may or may not record the maximum wave pressure that occurs during a storm.
3. The mean intensity of pressure on a large area is hardly possible of direct measurement.
4. For estimating the probable mean wave pressure in any given locality the use of a reliable formula is, in the present state of our knowledge, the only method practicable.

Need for Revision of Fundamental Theories on Strength and Suitability of Engineering Materials

Presidential Address delivered Aug. 25, at Cardiff Meeting of the Engineering Section of the British Association

The importance of research in all branches of industry is now becoming fully recognized. It is hardly necessary to point out the great possibilities of the Board of Scientific and Industrial Research, formed just before the war, or to lay stress on the attention which has been called to the need for research by events during the war. Probably in no branch of the services was more research work done than in the Air Service and the advances made in all directions in connection with flying were astonishing. My own work was confined to problems connected with materials of construction, and as a result of that work I have come to the conclusion that the time has come when the fundamental data on which the engineering theories of the strength and suitability of materials are based require thorough overhauling and revision. I believe that the present is a favorable time for this work, but I think that attention needs to be drawn to it, lest research work is all diverted to the problems which attract more attention owing to their being in the forefront of the advancing engineering knowledge, and lest the necessary drudgery is shirked in favor of the more exciting new discoveries.

It has been very remarkable how again and again in aeroplane engineering the problems to be solved have raised fundamental questions in the strength and properties of materials which had never been adequately solved. Some of these questions related to what may be termed theory, and some related to the physical properties of materials. I propose today to describe some of these problems, and to suggest the direction in which revision and extension of our fundamental theories and data are required and the lines on which research should be undertaken.

Calculation of Strength of Timber.—Let us consider first one of the oldest materials of construction—timber. Timber was of prime importance in aircraft construction. The first peculiarity of this material which strikes us is that it is anisotropic. Its grain may be used to locate three principal axes—along the grain, radially across the grain, and tangentially across the grain. It is curious that there do not appear to be generally recognized terms for these three fundamental directions. A very few tests are sufficient to show that its strength is enormously greater along the grain than across it. How, then, is an engineer to calculate the strength of a wooden member? There is no theory, in a form available for the engineer, by which the strength of members made of an anisotropic material can be calculated.

I fancy I may be told that such a theory is not required—that experience shows that the ordinary theory is quite near enough. How utterly misleading such a statement is I will try to show by a few examples. Suppose a wooden tie or strut is cut from the tree obliquely so that the grain does not lie parallel to its length. In practice it is never possible to ensure that the grain is accurately parallel to the length of the member and often the deviation is considerable. How much is the member weakened? This comparatively simple problem has been of immense importance in aeroplane construction, and thanks to the researches made during the war, can be answered. The solution has thrown a flood of light on many failures which before were obscure. If the tensile strengths of a piece of timber are, say, 18,000 lb per square inch along the grain and 800 lb. per square inch across it—radially or tangentially—and the shear strength is 900 lb per square inch along the grain—these figures correspond roughly with the strengths of silver spruce—then if a tensile stress be applied at any angle to the grain the components of that stress in the principal directions must not exceed the above strengths, or failure will occur. Thus we can draw curves limiting the stress at any angle to the grain, and similar curves may be drawn for compression stresses. These theoretical curves have been checked experimentally, and the results of the tests confirm them closely, except in one particular. The strengths at small inclinations to the grain fall even faster than the theoretical curves would lead us to expect. The very rapid drop in strength for quite small deviations is most striking.

Similar curves have been prepared for tensile and compressive stresses inclined in each of the three principal planes for spruce, ash, walnut, and mahogany, so that the strengths of these timbers to resist forces in any direction can now be estimated reasonably accurately.

Improvement in Manufacture of Plywood. As a second example consider the strength of plywood. Plywood is the name given to wood built up of several thicknesses glued together with the grain in alternate thicknesses running along and across the plank. Plywood is generally built up of thin veneers, which are cut from the log by slicing them off as the log revolves in a lathe.

Owing to the taper in the trunk of the tree and to other irregularities in form, the grain in the veneer rarely runs parallel to the surface, but generally runs through the sheet at a more or less oblique angle. As a consequence the strength of plywood is very variable, and tests show that it is not possible to rely on its having more than half the strength it would have if the grain in the veneers were not oblique. It is therefore obviously possible to improve the manufacture enormously by using veneers split off, following the grain, in place of the present sliced veneers. The superiority of split or riven wood over cut wood has been recognized for ages. I believe all ladders and ladder rungs are riven. Hurdles, hoops, and laths are other examples. Knees in ships are chosen so that the grain follows the required outline.

Owing to the enormous difference in strength in timber along and across the grain, it is obviously important to get the grain in exactly the right direction to bear the loads it has to carry. The most perfect example I ever say of building up a plywood structure to support all the loads on it was the frame of the German Schütte-Lanz airship, which was made entirely of wood. At the complex junctions of the various girders and ties the wood, which was built up of very thin veneers—hardly thicker than plane shavings—layers were put on most ingeniously in the direction of every stress.

Misleading Tests of Timber.—Many of the tests applied to timber are wrong in theory, and consequently misleading. For example, the common method of determining Young's modulus for timber is to measure the elastic deflection of a beam loaded in the middle and to calculate the modulus by the ordinary theory, neglecting the deflection due to shear, which is legitimate in isotropic materials; but in timber the shear modulus is very small—for example, in spruce it is only about one-sixtieth of Young's modulus—and consequently the shear deflection becomes quite appreciable, and the results obtained on test pieces of the common proportion lead to errors in the calculated Young's modulus of about 10 per cent.

There are some valuable tropical timbers whose structure is far more complex than that of our ordinary northern wood. The grain in these timbers grows in alternating spirals—an arrangement which at first sight is almost incredible. The most striking example of this type of wood I have seen is the Indian "Poon." If a sample is split in a series of tangential planes at varying distances from the center of the tree, it will be seen that the grain at one depth is growing in a right-hand spiral round the trunk; a little farther out it grows straight up the trunk; further out again it grows in a left-hand spiral, and this is repeated again and again with a pitch of about 2 in. The timber is strong and probably well adapted for use in large pieces—it somewhat resembles plywood—but it is doubtful whether it is safe in small pieces. No theory is yet available for estimating its strength, and very elaborate tests would be needed to determine its reliability in all positions. I had to reject it for aeroplanes during the war for want of accurate knowledge of its properties.

These examples show how necessary it is to have a theory for the strength of anisotropic materials before we can either understand the causes of their failure or make full use of their properties or even test them rationally.

A Few Fundamental Questions Regarding Steel. The second material we shall consider is steel, and in dealing with it I do not wish to enter into any of the dozen or so burning questions which are so familiar to all metallurgists and engineers, but to call your attention to a few more fundamental questions. Steel is not strictly isotropic—but we may consider it to be so today. The first obvious question the engineer has to answer is, "What is its strength?" The usual tests give the ultimate strength yield point, elastic limit, the elongation, the reduction of area, and perhaps the Brinell and Izod figures. On which of these figures is the dimension of an engine part, which is being designed, to be based? If we choose the ultimate strength we must divide it by a large factor of safety—a factor of ignorance. If we choose the yield point we must remember that none of the higher-grade steels have any yield point, and the nominal yield point depends on the fancy of the tester. This entirely imaginary point cannot be used for accurate calculation except in a very few special cases. Can we base our calculation on the elongation—the reduction of area—the Izod test? If we face the question honestly we realize that there is no known connection between the test results and the stress we can safely call on the steel to bear. The only connecting link is that cloak for our ignorance—the factor of safety.

I feel confident that the only reliable property on which to base the strength of any engine part is the suitable fatigue limit. We have not yet reached the position of being able to specify this figure, but a considerable number of tests show that in a wide range of steels—though there are some unexplained exceptions—the fatigue limit for equal ± stresses is a little under half the ultimate strength, and is independent of the elastic limit and nominal yield point, so that the ultimate strength may be replaced as the most reliable guide to true strength, with a factor—no longer of ignorance, but to give the fatigue limit—of a little over 2.

Need for Extensive Tests for Fatigue Limit.—If the fatigue limit is accepted as the only sound basis for strength calculation for engine parts, and it is difficult to find any valid objection to it, then it is obvious that there is an urgent need for extensive researches in fatigue, for the available data are most meagre. The work is laborious, for there is not one fatigue limit, but a continuous series, as the signs and magnitudes of the stresses change. Many problems in connection with fatigue are of great importance and need much fuller investigation than they have so far received—e. g., the effect of speed of testing; the effect of rest and heat treatment in restoring fatigued material; the effect of previous testing at higher or lower stresses on the apparent fatigue limit of a test piece. Some observers have found indications that the material may possibly be strengthened by subjecting it to an alternating stress below its fatigue limit, so that the results of fatigue tests may depend on whether the limit is approached by increasing the stress or by decreasing it.

Improved methods of testing are also needed, particularly methods which will give the results quickly. Stromeyer's method of measuring the first rise of temperature, which indicates that the fatigue limit is passed, as the alternating load is gradually increased, is most promising; it certainly will not give the true fatigue limit in all cases, for it has been shown by Bairstow that with some ranges of stress a finite extension occurs at the beginning of a test and then ceases, under stresses lower than the fatigue limit. But the fatigue limit in that case would not be a safe guide, for finite changes of shape are not permissible in most machines, so that in that case only Stromeyer's test may be exactly what is wanted. It can probably be simplified in detail and made practicable for commercial use. Better methods of testing in torsion are also urgently needed, none of those at present used being free from serious defects. Finally, there is a fascinating field for physical research in investigating the internal mechanism of fatigue failure. Some most suggestive results have already been [illegible] obtained by Ewing.

For members of structures [illegible] steady loads I suggest that [illegible] by limiting the corresponding [illegible] amount—perhaps ½ per cent [illegible] has been tentatively adopted [illegible] specifications by specifying [illegible] tained without a permanent [illegible] ½ per cent. Whether this principle [illegible] and how it will answer in practice [illegible] by experience. It is at any rate [illegible] termining the useful strength of [illegible] loads.

Modifications Required in Common Theory of Strength of Materials. If we admit that the [illegible] basis for engine strength calculations [illegible] of interesting modifications required in the [illegible] theory of the strength of materials. It will [illegible] to neglect, as has been so general in the past, the [illegible] distribution of stress in irregularly shaped parts of machines. It has been generally recognized that sharp corners should be avoided when possible, but no theory is available to enable the stresses at corners to be calculated or to enable their effect on the strength of the member to be estimated. If fatigue is the critical factor in failure under fluctuating stresses such theory is most necessary. Even the roughest guide would be of great value. The nature and magnitude of the concentrations of stress which occur in practice have been investigated experimentally by Professor Coker by his elegant optical method which has given most valuable results, some of which are already being used in designing offices. If the mathematical theory is too difficult, it may be possible to lay down practical rules deduced from such experimental results, but the method still has many limitations, perhaps the most serious being that it can only be used on flat models. I believe Professor Coker expects to be able to extend the method to round models.

As a simple example to show the importance of the subject let us consider the effect of a groove round a straight round bar subject to alternating tension and compression, such a groove as a screw thread. There will be a concentration of stress at the bottom of the groove. The ratio of the stress at the bottom of a groove to mean stress in the bar has been worked out mathematically by Mr. A. A. Griffith, and his calculations have been confirmed experimentally by his soap-bubble method. The ratio depends on the relation between the depth of the groove, the radius at the botom, and slightly on the angle between the sides. For a Whitworth form of thread the ratio will be about 3. If the fatigue limit is exceeded at the bottom of the groove the metal will fail and a minute crack will form there; this crack will soon spread right across the bar and total failure will result. Thus we see that the safe mean stress in the bar will be reduced to one-third what a plain bar will bear. The truth of the theory regarding the importance of concentrations of stress has still to be proved experimentally; if true, it is of far-reaching importance, since it applies to all concentrations of

---

Concrete Blocks as Substitute for Ashlar. Concrete blocks as a substitute for ashlar, according to Revue des Matériaux de Constructions, are rapidly gaining in popularity. By carting the raw materials to the site, the cost of transport is much less than for worked stone (which must be more carefully handled), and if a fairly rapid-setting cement of good quality is used, the number of molds required may be reduced to a minimum. A small gang of men can rapidly mold all the blocks required—even the most complex—and they are then ready to be placed in position. Monotony of design is easily avoided when a sufficiently large number of dwellings are required, and in many cases, at the present time, the need for rapid construction is so great that esthetic considerations are relegated to the background. A pillar and panel type of structure lends itself best to rapid construction, and if the blocks used have an average volume of [illegible] cu. in., so that about 40 blocks form a cubic yard, they will be handled so conveniently that even if they cost more to produce than worked stone, they save the cost of delivery and gain in rapidity of laying.

Engineering Features of Strengthening of St. Paul's Cathedral

[illegible]

The fact that it has been necessary [illegible] on behalf of the Dean and the [illegible] of St. Paul's Cathedral [illegible] considerable interest to engineers.

It was evident when the [illegible] first [illegible] that prompt [illegible] to [illegible] the safety of the structure. The work which [illegible] of a careful inspection of the fabric was [illegible] continued without intermission even during the war [illegible] that any postponement in the [illegible] strengthening operations would be fraught with danger to the cathedral. The report on the condition of the building indicated that the foundations had [illegible] with the abundance of cracks and fissures in the buttresses and piers and the springing of the arches. The scheme which was accordingly prepared provided in the first place for the [illegible] repair of the buttresses of the dome, the grouting of [illegible] of the [illegible], and the repair of the southwest pier, one of the eight supporting the weight of the dome. This work was completed last year and similar operations are [illegible] in hand on the adjoining pier. The experience gained during the first stage of the work [illegible] what now remains to be done will be largely of a repetition character—has been extremely valuable. The greatest care had, of course, to be taken in the strengthening of the southwest pier, before work had been done on the other, there should be no disturbance of the great load, calculated at 8,000 tons. It is a matter of congratulation to all concerned with the work that none of the fears naturally entertained while a work of this description was in progress was realized, and that the strengthening operations on other piers can be proceeded with in a spirit of confidence that correct methods have been adopted.

Defects of Design. Before discussing the details of the work, it should be pointed out that, for whatever reason, Wren did not carry the foundations of the cathedral through the bed of wet sand which, to a depth of 20 ft., is here superimposed upon the London clay, but was content to lay them in the surface sand which extends to a depth of only 4 ft. [illegible] below the floor of the crypt. The assumption made at the time of erection that the fabric would stand for 200 years was not, it would appear, a wild estimate. It is believed, however, that the building might have subsided to a much greater extent but for the existence of the wet sand deposit below the foundations, and partly for this reason proposals to bore tunnels in the neighborhood of St. Paul's, which might have the effect of draining away the water and causing drying and shrinkage of the sand, have always been opposed, so far with success.

The investigations which were made before the repairs were put in hand, and information that has since come to light, show that there was a good deal of cheap work put into the building of St. Paul's, partly perhaps due to want of adequate supervision over contractors, but also, no doubt, because Wren lacked the necessary funds to carry out things in the grand style which he favored. The whole of the piers, for example, contain rubble filling, the quality of which is very variable; indeed, the whole character of some of the piers is much inferior to that of others. There are also iron cramps inside the stone work, many of which were put in by Mylne, the surveyor of the cathedral during the second half of the 18th, and the early part of the 19th, century, who carried out a restoration in 1781 and the following year. During this work the cathedral was closed, whereas during the present strengthening scheme there has been no interfering with the use of the structure. In many cases these iron cramps have been found to be rusted inside the masonry, and have split it in all directions, and it has been necessary to remove all the old metal, and where desirable, replace it by copper. The old stone walling was unable to carry the full weight of the dome, and as the filling of the piers dried with the lapse of time deterioration proceeded with more rapid strides.

Methods of Strengthening.—Work on the piers is being carried out in great detail, the method employed being to solidify by liquid grouting, as well as to put in new masonry where necessary. The result has been to consolidate more than 50 per cent of the old work. It was found in the course of the operations that Portland stone was not invariably employed in the construction of the piers, Burford stone being used in the pitch of some of the arches. This was discovered to be very badly cracked, and it was necessary to insert Portland stone in addition to cement grouting.

An interesting feature in connection with the construction of the piers is the gradual reduction in the area of the masonry with height from foundation level; but this will not affect the strengthening scheme which is now in progress. It is hoped that work on the second pier will be finished by the end of the present year, and it is then intended to put in hand similar operations on the northeast pier, where the original work has suffered considerable deterioration. It is obvious that if the whole of the piers have to be treated in the same way, the work will occupy a great many years, while it will probably also be necessary to carry out further repairs in connection with the buttresses, the function of which is to take the outward thrust of the dome. In order to facilitate the work, as well as to add to the safety of the operations, it is now proposed to use steel centering. Engineers who have been consulted believe that the danger of further subsidence of the cathedral has been greatly reduced by the work on the southwest and adjoining pier, as it was in this direction that the dome was subsiding.

Whether it will be necessary at some future date to underpin the foundations of the cathedral it is difficult to say. The operation would be both difficult and costly, and it is hoped that the grouting and strengthening of the piers and buttresses now in hand may serve the purpose of providing for the permanent safety of Wren's masterpiece.

Stability of Thin Walls and Heat Transmission

From The Surveyor, London, Aug. 20, 1920.

The subjoined sections of the report of the Building Materials Research Committee under the Department of Scientific and Industrial Research are published by the Ministry of Health in advance of the body of the report. These sections comprising the results of researches on the stability of thin walls, and heat transmission through thin walls, are based on experimental work carried out under the direction of the committee. The figures given must only be taken as giving the results of certain tests carried out on the materials mentioned under the conditions specified. It must not be assumed that the strength of walls under average constructions will necessarily reach the standard of the figures quoted.

Stability of Thin Walls.—It is generally realized that the actual stability of unsupported walls only a few inches thick is very small, and that such walls in practice always receive support either at the top or sides or both. It appeared, therefore, to the committee that the most practical method of attacking the problem was to ascertain the breaking strength of typical walls when subjected to crushing loads and horizontal pressure applied to the walls while held at the top and bottom. This would correspond roughly to a wall having in it two door openings, the strength of a wall with no openings being somewhat greater.

The difficulty of applying loads by directly weighting the walls was realized. It was found possible to secure the use of a hydraulic testing machine, which was capable of crushing short walls 8 ft. 6 in. high, which is about the height between floors in a building of the cottage type.

Tests were made on several commonly used materials, and each material was loaded to destruction in three ways: (1) Small cubes, generally 6 in. or 9 in. square, were crushed in order to ascertain the strength of the material when not used as a thin structure; (2) columns or pillars 14 in. wide from 2⅝ in. to 4½ in. thick, and 8 ft. 6 in. high. These narrow, thin walls or pillars were crushed, and their relative strengths compared with the cubes ascertained; (3) short lengths of wall 3 ft. 6 in. wide from 2⅝ in. to 4½ in. thick and 8 ft. 6 in. high. These were subjected to a vertical load of about 1 ton per lin. ft. of wall, and, while thus loaded, a horizontal pull was applied to the wall at the middle of its height until failure took place.

As the investigation was somewhat tentative, a part only was undertaken in the first place, and a second series of tests was begun after the first results were available. The results are given in Table 1.

Considered as a whole the results obtained are remarkably consistent, more so than is usually the case in tests of full-sized specimens. The principal facts brought out are the high relative resistance to crushing shown by the slender walls or pillars, and the weakness of the lime mortar compared with Portland cement when tested in this way. With the exception of the wall built with lime mortar, the crushing strength of the walls varies from 67 to 83 per cent of the strength of the same material crushed in cubes. The lime mortar showed 32 per cent. The high percentage strength is to some extent due to the care exercised in centering the column under test. It is, however, clear that strengths approaching these can be developed in practice, provided care is exercised in the bedding of the joists so that the load acts as nearly as possible through the center of the wall. It is also necessary that the wall should be absolutely vertical.

Reference to items 5 and 6 of Table 1 shows that the walls built with Fletton bricks on edge in cement (2⅝ in. thick) resisted a much higher crushing load and horizontal

TABLE I—RESULTS OF EXPERIMENTS ON STRENGTH OF THIN WALLS.

Description.	Crushing strength of cube. Lb. per sq. in.	Age of cube when tested. Days.	Crushing strength of wall 14 in. wide by 8 ft. 6 in. high. Lb. per sq. in.	Age of wall when tested. Days.	Horizontal pull to break wall 3 in. to 6 in. x 8 ft. 6 in. high under vertical load of 1 ton per ft. run. Lb.	Age of wall when tested under horizontal pull. Days.	Remarks.
1. Stock bricks 3 to 1 cement mortar wall 4½ in. thick (9x3x9)...... ..	770	26	638	24	895	34	In this specimen a vertical load of 2 tons per ft. run applied in connection with horizontal pull test.
2. Ditto, 6 to 1 cement mortar......	720	26	562	23	791	41	
3. Fletton bricks 3 to 1 cement mortar wall 4½ in. thick.	1,530	26	1,040	24	781	39	
4. Ditto 6 to 1 cement mortar wall 4½ in. thick	1,250	26	930	23	705	36	
5 Ditto, 3 to 1 lime mortar wall 4½ in. thick	1,050	22	330	24	375	27	
6. Ditto on edge, 3 to 1 cement mortar wall 2⅝ in. thick	1,170	29	1,040	23	553	44	
7. Concrete, 1:2:4 wall 4½ in. thick, cast in one piece	1,180 2,250	22 42	1,230	26	1,262	27	
8. Concrete blocks, 1:2:4, set in 3 to 1 cement mortar wall 4½ in. thick 18 in. x 9 in. x 4½ in.	1,180 2,250	22 42	1,510	22	1,253	25	
9. Concrete blocks (Winget, 1:2:4) wall 4½ in. thick (block 6 in. x 6 in. x 4½ in.)..	745	120	580	21	962	44	
10. Concrete blocks, 1:2:4 (wet process) wall 3 in. thick (block 6x6x6 in.; 6x6x3 in.)	1,630* 1,210*	29 29	1,130	21	700	32	
11. Coke breeze blocks, wall 3 in. thick (6x6x3 in.)... .	[illegible]	Unknown.	170	22	467 (slab)	41	
12 Coke breeze blocks, wall 4 in. thick (6x6x4 in.)	243	Unknown.	173	22	658 (slab)	41	

*These specimens were cut from a larger block as true as possible, but not faced, and no doubt were really stronger than the tests indicate.

pull than those built with the same bricks laid flat in lime mortar ($4\frac{1}{2}$ in. thick).

The coke breeze specimens showed low resistance to crushing, but a comparison of the strength of the cubes with that of the walls shows that, in spite of the low strength of the material, the percentage of strength in the wall is high as compared, for example, with that shown by the wall composed of Fletton bricks. Against the horizontal pull they gave better results than would be expected. All the concrete and breeze blocks show a high resistance to the transverse loads as compared with walls formed from smaller units such as bricks.

It appears from the tests that walls as thin as 2½ in. can safely be used for partitions in cottage building even when supporting the joists.

Heat Transmission Through Thin Walls.—The degree of physical comfort experienced in an ordinary dwelling house depends to a great extent upon the thickness and construction of the outer walls. In dwellings of Devonshire cob or similar construction the comparative weakness of the materials composing the walls in resisting compressive stresses render it necessary for the walls to be much thicker than is ordinarily the case in brick houses. As a result, dwellings of this type are noted as being cool in summer and warm in winter. Other methods, of which the use of the ordinary unventilated cavity wall is one, are sometimes adopted with a view to obtaining a warm dwelling.

Tests of the heat loss through various types of thick walls have been made from time to time; of these, special attention may be directed to the work carried out by Mr. A. H. Barker, W.H.S., B.A., B.Sc., Prof. W. M. Thornton, D.Sc., D.Eng. of Armstrong College, and at the National Physical Laboratory. A considerable amount of work on this subject has also been done abroad, particularly in America and in Germany. The committee thought, however, that further tests were desirable in reference to thin walls and walls of new types of construction. They therefore decided to ask Mr. Barker to undertake for them a research into the heat transmission through some seven different types of wall. The results obtained are summarized below.

When heat is passing from a region of comparatively high temperature through a partition of some kind to a region of low temperature the heat transmitted can be said broadly to depend on—

(1) The construction and material of the wall.
(2) The character of the surface of the wall;
(3) The area of wall;
(4) The temperature difference between the regions of high and low temperature.

The actual heat transmitted in British thermal units in still air will then for any particular case be given by the formula:—

$$H = K (t - t) A$$

where:

H = British thermal units transmitted per unit time
t = Higher temperature in degrees Fahrenheit
t = Lower temperature in degrees Fahrenheit
A = Area of the wall in sq. ft.
K = A constant, depending upon construction and material of the wall and condition of the surface.

It will be seen, then, that the constant K (sometimes termed the coefficient of transmission) will be a measure of the efficiency of the wall as a heat-insulating structure, representing the overall value of the transmission in British thermal units per sq. ft. per hour per degree difference of temperature on the two sides of the wall.

Values of this constant K for the walls tested by Mr. Barker are given below:

Type of wall.	Value of K
9 in. plain unplastered brick wall (London Stock)	[illegible]
$4\frac{1}{2}$ in. plain brick wall unplastered	[illegible]
$4\frac{1}{2}$ in. double brick wall, 3-in. cavity (without ventilation)	[illegible]
$4\frac{1}{2}$ in. double brick wall, 3-in. cavity (ventilated top and bottom	0.42
$4\frac{1}{2}$ in. rough ballast concrete 6 to 1	[illegible]
$1\frac{1}{2}$ in. rough breeze concrete	[illegible]
6 in. rough ballast concrete	[illegible]
9 in. concrete blocks with cavity in each block	[illegible]
4 in. hollow brick tile	0.41
4 in. ballast concrete wall outside 2-in. cavity and 1-in. coke breeze concrete inside (without ventilation)	[illegible]
4 in. ballast concrete wall outside 2-in. cavity and 1-in. coke breeze concrete inside (ventilated top and bottom)	[illegible]

Thus, of the walls tested by Mr. Barker, the $4\frac{1}{2}$-in. rough ballast concrete wall offers the least resistance, while the 4-in. concrete cavity unventilated wall with the inner portion of coke breeze offers the greatest resistance to the flow of heat. The latter type of wall doubtless partly owes its efficiency as a heat insulator to the porous nature of the breeze as it is, of course, a well known fact that good insulators such as cork, slag wool or wood owe their insulating properties to the large number of small air spaces contained within their mass.

It will be noticed that in these examples the difference in the value of K with a cavity wall when ventilated and not ventilated appears to be small, but the effect of ventilation on the transmission of heat is governed by the extent to which circulation occurs in the cavity under ordinary weather conditions. This will depend upon the force of the wind, which on some days might be very high, and on the difference between the temperatures of the inner and outer atmospheres. Either or both of these factors might have the effect of increasing the circulation if ventilation is provided both at the top and bottom of the cavity.

It may be said, therefore, that comparatively little is lost in the insulating effect of the wall by providing a limited amount of ventilation in the cavity, particularly if this is arranged at the base of the cavity only.

The loss of heat in all the walls may be greater under actual conditions than these tests indicate, owing to the increased cooling effect which would be produced by the action of wind or the evaporation of damp on the external surface of the wall. This might reduce the temperature of the external face of the wall by as much as two or three degrees below that of the surrounding air, depending upon the wet bulb temperature obtaining at the time.

Experiments of the Metropolitan Water Board with Rapid Filtration

From The Engineer, London, Sept. [illegible], 1920

The latest report* of Sir Alexander C. Houston, Director of Water Examination of the Metropolitan Water Board, London, is principally concerned with the question of how far the "rapid filtration" of stored river water is capable of producing supplies which are safe and suitable for human consumption, and we propose to deal more especially with that part of it.

The question at issue so far as the present report is concerned really amount to this: "Is it permissible to filter stored water so rapidly as to create a material economic gain in the saving of filtration area and yet, by the aid of ante-filtration or post-filtration sterilization process, to produce a water which is epidemiologically safe, innocuous, tasteless, and reasonably satisfactory from a physical and sentimental standpoint?"

Though realizing that it is desirable, when considering—even tentatively—any question of modified processes of water purification, to start with the quality of raw river water, Sir Alexander in the present report only deals with the problem as it affects stored water. If his views be sound, he remarks, Thames River water after adequate storage is apparently safe for domestic use, even without filtration, though it requires further treatment to remove suspended matters and render it attractive from the physical point of view. Nevertheless, he has always advised careful filtration of the water, despite the high value that he places on storage, and he does not now suggest even the tentative consideration of any departure from old time procedure, unless it involves equal or greater security. Greater security, however, could undoubtedly be achieved by a chlorination process, and that fact leaves open for discussion the question of substituting—in connection with new works—a less expensive "rapid" for a more costly "slow" sand filtration process.

Sir Alexander, in order to avoid ambiguity, sets out the two proposals, side by side, as follows:

Present "slow sand filtration method"	Alternative "rapid filtration method"
(1) Storage.	(1) Storage.
(2) Slow sand filtration.	(2) Very "rapid filtration" with or without a coagulant.
	(3) Ante-filtration or post-filtration, chlorination

A vital factor in arriving at a final conclusion in the matter is, it is pointed out, whether the use of a coagulant is or is not essential to the successful operation of mechanical filters. With nearly all "rapid filters" a coagulant—usually aluminum sulphate—is employed in order to produce an artificial skin on the surface of the filtering medium and, in the endeavor to render the filtrate as satisfactory, chemically and bacteriologically, as would be the case if the water had been filtered slowly through ordinary sand filters. Taking the dose required as only one grain per gallon, the pre-war cost for the chemical worked out at some six shillings per million gallons with aluminum sulphate at £4 14s per ton. The price of the chemical at the time the report was written was about £17 per ton, so that the cost per million gallons had risen to, say, 21s 8½d.

---

*Metropolitan Water Board—Thirteenth Research Report. By Sir Alexander C. Houston. London: P. S. King and Son Limited. Price [illegible]

Now, in order to clarify peaty water or to remove bacteria from contaminated water the use of a coagulant is almost essential, but adequately stored Thames water is not greatly discolored, and what coloring there is is not so readily removed by coagulants as is the brown color of a freshly drawn sample of raw river water. Moreover, water stored in a reservoir for an adequate period of time may be considered reasonably safe epidemiologically, and since the proposal under consideration embodies the employment of ante or post-filtration sterilization, the use of a coagulant may be considered unnecessary. Furthermore, excluding the "plankton" of stored water the suspended matters in stored Thames water are not of a kind which urgently require the use of a coagulant, and if coagulants could be ruled out, the problem would be simplified, as, in addition to the avoidance of heavy working costs, the interest on capital expenditure on apparatus and mixing and settling tanks incidental to the use of coagulants would not have to be taken into consideration.

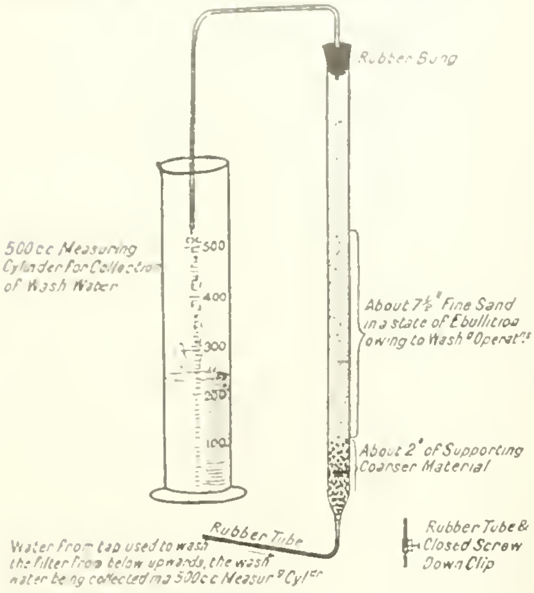

Rubber Bung
500 cc Measuring Cylinder For Collection of Wash Water
500
400
300
250
100
About 7½" Fine Sand in a state of Ebullition owing to Wash g Operat'n
About 2" of Supporting Coarser Material
Rubber Tube
Rubber Tube & Closed Screw Down Clip
Water from tap used to wash the filter from below upwards, the wash water being collected in a 500 cc Measur g Cyl'r

Fig. 1—Experimental Filter.

Hence, for the purposes of the report, Sir Alexander takes the bold course of assuming the possible non-use of coagulants, the filtration of an adequately stored water at the enormously rapid rate of from, say, 100 to 200 gal. per square foot per hour—which, as he says, at once places "rapid filtration" on a highly economical basis—no chemical purification and no bacteriological improvement other than that produced by chlorination. In this connection it should be noted that he has very definite views as to the absolute necessity of employing sterilization in connection with mechanical filters. To use his own words, he says: "It must be definitely understood that the writer considers a chlorination process essential if 'rapid filtration' methods are to be seriously entertained. Any conception of saving money at the possible expense of health security is obviously inadmissible."

For the purposes of his investigations Sir Alexander instituted two series of experiments. The first series was carried out in the laboratory, while the second was conducted outdoors and more or less under actual service conditions. For the former the small filtering apparatus which is illustrated in Fig. 1 was employed. It consisted of a glass tube about 18 in. long and ¾ in. in diameter with the lower end drawn down. About 2 in. of small to very minute pebbles occupied the lower end of the tube and served to support some 7½ in. depth of "mature" fine sand. By "mature" sand is meant sand which has been in use for a very long time on a filter bed, such sand being much more effective than sand which has never been used for water purification purposes. Before commencing the tests the lower end of the filter was connected by means of a rubber tube with a tap. When the water was gently turned on it had the effect of thoroughly washing the sand from below upwards—the particles being violently disturbed by the up-flowing water. The procedure also had the effect of grading the sand, the coarser particles settling to the foot of the tube and the finer sizes rising to the surface. This washing operation was carefully performed before each separate test. Finally, the rubber tube was quickly removed and a small length of tube, which was fitted with a screw regulating clip, substituted. The filter tube was then left nearly full of sand and water. Then when conditions had become settled, the screw clip was loosened so that the water gradually escaped until its top surface had nearly reached the level of the sand. The water to be tested was then poured into the top of the tube and allowed to filter through, the rate of filtration being governed by means of the screw clip. The first three ounces—about 85 c.c. coming through were rejected and the next 420 c.c. collected. A measured volume of the filtrate was next centrifugalized, the supernatant liquor poured off, and a known amount of the deposit placed inside a small cell formed by glueing a ring of aluminum to an ordinary glass slide. The sediment was examined microscopically and was often photographed. The test—unfiltered—water was similarly centrifugalized and served as the control.

A great many experiments were carried out with stored waters containing all sorts of growths, and the conditions of experiment were constantly being varied. Very slow, medium, and excessively rapid rates of filtration were tried and sometimes aluminum sulphate was used as a coagulant. The addition of that substance in large or small doses did not, however, under the conditions of experiment, so materially improve matters as regards keeping back the smaller cells as perhaps might have been anticipated.

The conclusion was gradually reached that nearly as good results were obtained as regards holding back practically all the larger growths—for example, fragilaria, asterionella, synedra, synchaeta, daphnia, cyclops, glenodinium, eudorina, polyartha, volvox, uroglena, bosmina, cosmarium, pandorina, etc.—in water with very rapid, as with very slow, rates of filtration. The smaller elements seemed to pass through the filter very easily, and although the improvement was doubtless greater the slower the rate of filtration, the results were relatively unsatisfactory, even when the rate of filtration was slowed down to a point which ceased to be economically attractive when compared with the ordinary sand filtration processes. Briefly, the results were, as regarded the larger growths, decidedly satisfactory, even with very rapid rates of filtration and were disappointing at low rates of filtration so far as the smaller elements were concerned. The trial of a sand so excessively fine as to be practically useless showed no marked advantages over that used in the investigation.

In explanation of the tests it is pointed out that if a filter held back all the suspended matter in a given volume of water, the "wash water" from the filter, when diluted with water free from suspended matter to exactly the same volume, should present the same appearance as the unfiltered water, and that in so far as it failed to do so the difference should appear in the filtrate. For each of a number of experimental filtrations Sir Alexander shows the reproduction of a series of three photographs. The first of each series represents the test water before filtration, the second "wash water" from the filter after filtration, and the third the filtrate. In all cases there is a marked similarity between the unfiltered water and the "wash water" as concerns the larger growths, whilst the filtrates in every case show an absence of larger growths though the smaller cells are present in quantity. Occasionally some of the larger elements appear in the filtrate; but, generally speaking, they are absent, though it was found impossible to filter at high speed, particularly if no coagulant were used, without some of the supended matters passing through the filters. Apparently the water used in all the indoor experiments was obtained from West Middlesex No. 5 reservoir, and the rates of filtration varied between such wide limits as 7 and 367 gal. per square foot per hour. In this connection it may be noted that the rates employed in slow sand filtration at the different works of the [illegible] Grand Junction to 2.32 (Clerkenwell) gal. per square foot per hour, or it would be more correct to say that these were the limits in pre-war, or normal, times.

The bacteriological results attained are noteworthy. The percentage reduction in the number of bacteria in the filtrates as compared with the numbers present in the raw water actually varied from [illegible] to [illegible]. In more than half the total number of cases, however, the reduction was 50 per cent or over. Of course, looked at [illegible] such reduction is not satisfactory, though of small consequence if sterilization is to be adopted. Still, it is interesting that, roughly speaking, one-half of the smallest forms of suspended matter was held back, and that they were so [illegible] is possibly explained, it is suggested, by the fact that the stored waters were, at the time, rich in such gelatinous growths as would doubtless go far to take the place of aluminum sulphate as regards surface skin formation. As evidence of how little the rate of filtration had to do with the percentage retention of such small suspended matters as bacteria, it is shown that in one experiment in which the filtration rates were 11 and [illegible] gal. per square foot per hour the bacterial reductions were 76 and 66 per cent respectively. In another case with filtration rates of 11 and 305 the reductions were [illegible] and [illegible] per cent respectively. Another interesting point is that, on the whole, the passage or non-passage of things of irregular dimensions seems to be governed more by length, so to speak, than by breadth. Further, all things of approximately equal size did not necessarily behave similarly. For example, the gelatinous cyclotella-stephanodiscus group of organisms, although relatively small, seemed to be largely held back by the filter, whilst other organisms of about the same size undoubtedly reached the filtrate.

As regards amorpheus suspended matters such as mud, silt, dirt, humus, etc., it must be remembered that they tend to be gradually deposited on the bottoms of reservoirs, the organic parts slowly undergoing decay, whilst the floating particles tend to become flocculated. In the absence of living growths the amorphous suspended matters in stored Thames water have never interfered seriously with the working of slow sand filters, and their absence from the filtrates has always been a satisfactory feature of that method of water purification. Sir Alexander points out that, on the whole, the results obtained with the "rapid" filter were good in respect of the holding back of amorphous matters, the photographs of the raw and "wash" waters showing about the same amount of dirt and those of the filtrates showing a fairly clean appearance, although not, he remarks, up to the standard of a slow sand filtered water.

Passing now to the "outdoor" experiments, it may be explained at the outset that they were made at the Hampton works and that two "rapid" filters were employed. The make of filter is not specified, but it is stated that one was larger than the other, and that the larger had a surface area of 50 sq. ft. The test water was derived from Walton reservoir, but it was not led directly to the filter, but was drawn from the top of two of the slow sand filter beds fed from it. Consequently the water contained not only the growths found in stored water, but also any additional growths which may have taken place on the top of the filter beds. This arrangement was not what Sir Alexander would have chosen if he could have had what he wanted. He would have preferred to take the water directly from the reservoir, but apparently it was not possible, with the filter in its existing position, to do that. As a matter of fact post-storage growths interfered with some of the experiments, but such interference would not be experienced in practical working, since, of course, under service conditions reservoir water only would be supplied to the filters.

The experiments with these two filters covered a period of practically a year; the year dealt with in the report. The rates of filtration employed varied between 50 and 200 gal. per square foot per hour, and occasionally aluminum sulphate was used as a coagulant. Without going into details it may be said that, generally, the results achieved were very similar to those arrived at with the laboratory apparatus, i. e., the larger growths were mostly held back by the filter, whereas the smaller cells passed through it in varying numbers. The percentage reduction in the numbers of bacteria was, however, found to be considerably higher than was the case in the laboratory experiments, as high a figure as 95.8 per cent reduction being given in one case and an 80 per cent reduction was apparently [illegible]. The chemical results were not, however, nearly so good as those characterizing the filtrate from slow sand filters. That point is not, as Sir Alexander remarks, of [illegible] importance providing the water is sterilized after filtration.

Discussing the experiments as a whole, Sir Alexander says that, during certain periods, when the "rapid" filter was not working properly and when [illegible] developments of growths had taken place, the color of the filtered water would probably not have attracted unfavorable comment when looked at in, say, a tumbler. As regards suspended matters he continues, the filtrate was fairly satisfactory, but it had not the "clean polished" look of slow sand filtered water, although it improved somewhat in that respect when aluminum sulphate was used. The supply of a drinking water might be permissible if it contained none or hardly any of the minute floating organisms found in water. Such organisms are microscopically small, but most of them are infinitely large when compared with bacteria. They are sometimes designated plankton and include the chlorophyceae (green algae), cyanophyceae (blue-green algae), diatomaceae, together with the protozoa, crustacea, rotifera, etc. The importance of such organisms is not that they are in any way harmful to health, but their presence in the pipes in sufficient abundance is fraught with dangers of a practical kind. "Thus," says Sir Alexander, "there are certain 'things' that can grow in pipes in the dark, e. g., the fresh water sponges and mussels, and if these or their spores pass the barrier of the 'rapid filters' and grow in the pipes, the consequence might be serious, partly by mechanically interfering with the flow of the water and also by giving the water an objectionable taste and smell. On the whole, it may be said that a filter, even when worked at exceedingly rapid rates, would hold back these growths and their reproductive elements. Yet it is difficult to feel certain that a few of the elements potentially capable of developing into full-sized growths might not escape occasionally into the pipes, and therefore everything depends upon whether the conditions in the pipes are favorable for their sustained development. They are animals and must feed to live, and although doubtless must has still to be learnt as regards their food, it is, at all events, certain that if the water contains no plankton life for them is impossible." As has been shown, the larger growths are held back by the "rapid" filter. There are, however, much smaller growths, e. g., cyclotella, raphidium, protococcus, pediastrum, scenedesmus, cercomonas, monas, cryptomonas, mallomonas, chlamydomonas, etc., and there are also the minute spores or reproductive elements of many organisms to be considered, and that some of them would pass through the filter is certain. Whether or not those remaining in the filtered water would provide sufficient food for the development in the pipes of such dark-loving animals as the sponges, bryoza and fresh-water mussels, is, however, Sir Alexander remarks, a debatable question. He is evidently inclined to think that they would not.

There is much more in the report regarding the foregoing and other matters. We cannot, however, afford space to report them specially, and must content ourselves with giving some of the conclusions at which his investigations have caused Sir Alexander to arrive. The first has already been mentioned. (a) It is the necessity of sterilization if "rapid" filters are employed. The cost of chemicals would, he states, only be from 1s. 1d. to 2s. 3d. per million gallons, and the treatment would render the water quite safe for drinking purposes irrespective of any other purification process. The taste problem—as we shall show later—is, if not already solved, in process of solution. (b) Extremely "rapid filtration" even without a coagulant, of an adequately stored water would remove nearly all the grosser impurities and a fair proportion of the minutest forms of life. (c) Unsatisfactory results as regards ammoniacal nitrogen, albuminoid nitrogen, and oxygen absorbed from permanganate may be condoned in the presence of an efficient sterilization process. (d) The color of the rapidly filtered water would excite little or no remark during about nine months of the year, but might be open to criticism during the remaining three months. (e) The rapidly filtered water would contain some suspended matter; not enough, perhaps, to merit serious objection, but sufficient to compare unfavorably with a slow sand filtered water. (f) The plankton—algal and other growths—of the stored water would be so largely removed by a "rapid filtration" process that the development of growths in the pipes would seem to be improbable. (g) Sir Alexander believes that a sterilization and rapid filtration" process would be considerably cheaper than slow sand filtration, and, further, that a combination of the two methods—new and old—with some modification of the latter presents many advantages. Among the modifications, it may be explained, would be increased rate of flow through the "slow" sand filters which would be possible, since the "rapid" filters would remove a large proportion of matters which would otherwise choke the sand filters.

Pile Driver for Sinking 200 Ft. Concrete Piles

From The Engineer, London, June 11, 1920.

During the execution of the foundation work for a large reinforced concrete bridge in Sweden it was found necessary to provide for piles up to 200 ft. in length in order to reach solid bottom, the circumstances being such as to prevent the driving of shorter piles with subsequent building up and re-driving.

Floating Pile Driver for 200 Ft. Long Reinforced Concrete Piles.

The bridge, which is 300 ft. long and connects Ropsten and Lidingo, is constructed with a number of 50-ft. spans, each of which is supported on piles varying in length from 75 ft. to 200 ft. The depth of water is about 60 ft. and the bottom consists of soft soil for a distance of about 80 ft. down, after which firm ground is encountered. A considerable part of the pile is thus unsupported, which necessitated ample dimensions to prevent buckling. Moreover, as the whole of the driving operations had to be carried out from the surface of the water the designers were faced with the difficulty of providing a pile 200 ft. long which was of sufficient stiffness to be handled and driven, and which would yet allow of easy transport to a floating pile-river. The problem was solved by constructing the piles as circular tubes between 3 ft. and 4 ft. diameter, reinforced with steel and built in a specially constructed dry dock, from which they could be floated out to the pile-driver. After driving they were filled with concrete.

The pile-driver, which, of course, had to be specially designed for the purpose, is mounted on four floating caissons built of reinforced concrete. The equipment is provided with pumping machinery for trimming during the handling and pitching of the piles. This trimming arrangement was also utilized to tilt the pile frame in order to drive the piles to a certain inclination, as required by the designers. In addition to the trimming pumps, force pumps were provided for actual driving purposes, two water jets being carried along the whole length of the piles diametrically opposite one another. Hydraulic hose, specially armored to support the weight due to the considerable length of hose filled with water, was obtained.

On account of the height of the pile-driver special precautions had to be taken against wind pressure, and a very broad base is provided so as to minimize the effects of wind tilting. The leaders are of the sliding type and admit of being lowered below water to a considerable depth, while guide rollers are fitted so as to keep the circular piles in place during the driving. The weight of the hammer was about 10 tons.

The whole of the pile frame was designed and built by Messrs. Christiani and Nielson, 25, Victoria St., Westminster, London, England, in connection with the design and execution of the reinforced concrete work of the bridge above and for which they were responsible.

Formalin as a Mosquito Destroyer

From Municipal Engineering and The Sanitary Record, London, Aug. 5, 1920.

The Paris correspondents of the daily papers have recently given particulars of recent work under the Pasteur Institute. Monsieur Rouband has been experimenting in the destruction of the malarial mosquito by sprinkling the water where it breeds with powdered formalin, and the results obtained are deemed satisfactory. It is mentioned that the method is only intended for the destruction of the Anopheles mosquito, the most dangerous of all the species, because it transmits the germs of malaria in a way peculiar to it alone. The larvæ of this species differ from those of the ordinary mosquito (Culex) in feeding on the surface of the water. Their nourishment consists of tiny floating particles which the larvæ draw automatically into their mouths by producing microscopic whirlpools by the aid of a special organ. It is stated that powdered formaline cannot be used for the destruction of larvæ other than those of the Anopheles mosquito. The quantities used—25 to 50 centigrammes being sufficient for one square metre of water—are so small that other organisms in the water are unharmed. Thus the water can be used for cattle, irrigation, laundry work and the keeping of fish, without any ill results. To this advantage is added that of the simplicity of the method, as the pōwder can be sprinkled bӯ hand, a good preparation being 1 part of powdered formaline to 10 parts of fine sand. Not only is the method particularly useful in the case of small amount of water for domestic uses, such as pools, cisterns, etc., which are the usual breeding places of the Anopheles mosquito in Europe, but it is also adaptable for use in great marshy areas where malaria is rife, as the powder finds its way among the reeds and grasses in a way oil does not. M. Rouband, in concluding his report on the experiments, regrets that this system does not include the destruction of the ordinary mosquito as well as of the malarial mosquito, since, while the former species are not nearly so dangerous, they are nevertheless harmful. He adds, however, that he hopes shortly to be able to make known a method for the destruction of their larvæ, also based on the same principles as the system for the destruction of the malarial mosquito.

The Birmingham Method of De-Watering Sewage Sludge

By F. R. O'SHAUGHNESSY,
Consulting Chemist to the Birmingham, Tame and Rea District Drainage Board

(Abstract of a paper presented to the [illegible] Section of the Royal Sanitary Institute [illegible])

As the result of the great amount of work [illegible] in recent years the purification of sewage liquor may be accomplished satisfactorily in various ways, but on the other hand the sludge problem still remains as a very troublesome and formidable one. We in Birmingham have consistently emphasized the ideal that the aim in treating both sewage liquor and sewage solids should be the production of an inoffensive end product by inoffensive means and at reasonable cost.

In the course of a discussion of a paper by Mr. S. E. Melling, F.I.C., on the activated sludge process in November, 1914, Prof. G. J. Fowler cited the following conditions to be fulfilled in addressing this problem, as follows:

"The scientific solution of the sewage problem will not be attained until the following results can be guaranteed for any given case:

"(1) An effluent which will not deteriorate the stream into which it flows.

"(2) No nuisance in the course of sludge disposal.

"(3) No nuisance from smell or from flies in connection with filter beds.

"(4) An expenditure strictly proportionate to the sanitary and esthetic results achieved."

At that date Prof. Fowler remarked that all four conditions were capable of fulfilment by the activated sludge process. Perhaps now, as a result of further experience of this wonderful process on a larger scale, it would be fairer to say that the veritable ease with which the sewage liquor is purified by the activated sludge process serves to bring out in greatrer relief the difficulties inherent in the treatment of the sludge.

Except in those few cases where the whole sewage can be passed direct to the sea or other large mass of water, the sewage problem is essentially a de-watering problem. Generally the bulk of the water, viz., say 99.95 per cent, is removed quite readily in sedimentation tanks from the solids which go to form most of the sludge, and it is the elimination of this last small proportion of water (which with the solids forms a slurry containing about 90 per cent of water) which furnishes the difficulty.

The problem is difficult because of two outstanding properties of the sludge—viz.: (1) It is offensive, which makes it difficult to handle; (2) it is a complex aqueous colloid, consisting of colloid forms, emulsoids, and suspensoids, which retain water with great tenacity owing to the presence of oils, soaps and gelatinous bodies, which confer considerable stability on the complex.

There are but few agencies capable of breaking up this complex, and also destroying its offensive character, viz.: (a) heat, and (b) biological decomposition. The first is ruled out because of expense, and there remains only the second, which is the agent exploited here in the process under discussion.

The Birmingham Process.—The bulk of the sludge consists of material which has already undergone at least partial degradation under the influence of biological agents. Hence there is a consistent principle about this Birmingham process in that it is sought to effect the further rapid chemical degradation of the organic contents of the sludge by promoting intensive fermentation in the mass, under controlled conditions.

The process is therefore a natural one, in that the disintegration of the organic matter into simpler materials is not interrupted, but is accelerated. It is, however, hardly correct to call it a process of auto-digestion, as has sometimes been done, for, if left to itself, the sludge will become so offensive as to create an intolerable nuisance. Rather are our efforts directed to maintain a particular kind of fermentation dominant, which shall insure that offensive volatile products of the reaction shall be reduced to a vanishing quantity, and all the operations thereby conducted without nuisance.

This result has, indeed, been secured for some eight years now, showing that the process is a success, for during that time the whole of the sludge from close on a million people has been brought to this [illegible]. For some [illegible] previous to 1912, when this process was inaugurated, [illegible] had caused [illegible] to [illegible], and the fact that the outfall at Saltley, where the digestion tanks are situated, is surrounded by thickly populated residential and [illegible] areas and that all complaints ceased after the present process was installed is evidence that in one most important respect a long step forward towards the goal aimed at was achieved.

It had long been noted that generally when the so-called "septic action" had become well established in a septic tank, or an old lagoon, the contents became covered with a thick crust and the fermentation proceeded in the tank without nuisance.

The next point established by us in Birmingham was that concentrated sludge could be made to behave in a similar fashion. This is indeed a point of great importance in practice, and differentiates the Birmingham method from the septic tank process and the methods of Travis and Imhoff, for in these latter the crude sludge enters the digestion chamber in very small increments.

In the Birmingham sludge digestion process the digestion chamber is entirely separate from the sedimentation tank in which the crude sludge is collected, and when being charged from the latter tank the digestion chamber will receive a dose of several hundreds of tons of crude sludge (containing about 90 per cent or so of water) in a few hours.

This, then, is the principle of the process, that with proper [illegible] and attention to details, which are referred to later, sludge can be made to undergo vigorous fermentation without causing nuisance, and thereby ultimately a black, inoffensive, mobile sludge is obtained which has profoundly altered its physical characteristics so that it will part with its water content fairly freely as compared with the original crude sludge. Usually this end product is pumped on to prepared plots about ½ an acre in area, which are leveled, drained and covered with several inches of ashes for the reception of about 18 in. of the sludge. By drainage and by evaporation the water escapes, leaving a firm, inodorous peatlike solid about 6 in. thick, which is lifted and carried to the tip.

The crude sludge is collected in five tanks of 1,000,000 gal. capacity each, and these are cleaned out about once a week. Under these conditions the water content of the resulting crude sludge is computed to be 92.5 per cent and the average amount about 1,000 tons per day (or 75 tons of dry solid matter per day).

The sludge digestion plant has a total estimated capacity of 28,250,000 gal., and in all gives to the sludge a digestion period of from four to five months on the average. This plant consists of 30 chambers, five of which (capacity 9,350,000 gal.), situated 5 miles from the Saltley plant, are used for the finishing operations. When about to empty a sedimentation tank of its crude sludge a block of digestion tanks (usually five in number) is partially pumped down to give sufficient space for the incoming charge of crude sludge. When it is thought desirable to thoroughly inoculate the crude sludge with active fermenting material (as in the colder months of the year) such material is drawn off by a small pump and delivered into the main carrying the crude sludge to the digestion tanks. Also "live" steam is delivered direct to the sludge main during the very cold weather to raise the temperature of the sludge and thus promote digestion.

As digestion of the sludge proceeds the colloid complex is steadily broken up and separation of water from the solids occurs. This water is drawn off at convenient intervals from time to time. The following are figures carefully computed for a period of four years, 1915-1918 inclusive:

SLUDGE STATISTICS FOR PERIOD COVERING FOUR YEARS, 1915-1918

Crude sludge removed from all tanks at Saltley outfall, tons	1,523,000
Representing dry solids (water 92.5 per cent), tons	88,000
Estimated dry solids from crude sludge from other outfalls, tons	22,000
Estimated digested sludge pumped from Saltley to lagoons, tons	781,000
Representing dry solids (88 per cent water), tons	72,860
Solids destroyed at Saltley by digestion, tons = 17%	15,200
Volume of digested sludge pumped to drying beds from lagoons, tons	661,000
Representing dry solids (88 per cent water)	62,500
[illegible] sludge lifted from drying area (25-30 per cent water), tons	141,000
Estimated dry solids in digested sludge carried to tip and stored in lagoons, tons	75,000
Estimated dry sludge destroyed by digestion, tons = 30-33%	35,000

Results from Birmingham Process. This figure of one-third for the proportion of the sludge destroyed by exhaustive digestion in this manner appears to agree with results obtained by a number of other observers.

The results obtained during the past 12 months agree very closely with those in the above table. It is a noteworthy fact that the rate of destruction of the sludge is at first rapid when fermentation is vigorous, but also diminishes rapidly. After a couple of months the rate becomes excessively slow. The sludge, however, is still very colloidal in character and will not part readily with the water present. It is both interesting and important to note that the major portion of the time required to bring the sludge into a fit condition to put on the drying beds is taken up chiefly, not with destructive fermentation of the sludge, but apparently with the change in the physical condition of the sludge from a highly complex colloidal state to a more simple and practically a non-colloidal state which parts with its aqueous contents with relative ease.

For instance, if the digestion of the sludge is carried out in a glass vessel the crude sludge adheres at first as a gummy paste to the walls of the vessel, rendering it opaque and the aqueous portion is also opaque. As fermentation dies down, more and more water is liberated, the water becoming less charged with colloidal matter, until ultimately, after the lapse of about five months, the aqueous contents become clear, the sludge appears as a dense coal-black mass, and ceases to adhere to the glass walls which become again clean and transparent.

There are some peculiar features about the behavior of the fermentation process which are important in practice.

With an industrial sewage, such as that from the Birmingham district, many substances find their way into the sewage which are inimical to bacterial life. Of these tar is the most troublesome, and it occasionally is sent down in such quantity that the digestion process is seriously hampered, as the tar becomes incorporated with the crude sludge. One such heavy dose of tar arrived at the works seven or eight months ago, and from time to time since other smaller doses have followed. Very great care and often special means are required to restore the action which has been poisoned in this way.

It has been mentioned that in the colder months resort is made to inoculating the crude sludge by drawing with a small pump on fermenting sludge from one of the active tanks in the installation. This mixing operation, as it is called, cannot be carried on indefinitely, for, after a time, if it is persisted in the fermentation loses vigor, and the action falls off. This phenomenon is a very curious one, and the cause of it somewhat problematical. Possibly it is due to loss of vigor on the part of the organisms responsible for the fermentation. When, owing to poisoning, or other causes, the process flags steps are taken to introduce new and vigorous organisms to the system, and the active fermentation is thereby restored. It will be seen, therefore, that constant watchful care is necessary to keep the action going satisfactorily.

It has been pointed out that if the crude sludge is left to itself a very offensive form of fermentation will inevitably assert itself, and, indeed, this will happen occasionally in individual tanks when for some reason the special "septic" fermentation fails. Some years ago the late Dr. Grossmann stated that sludge from which the fatty matter had been extracted was not capable of setting up a nuisance, and about 18 years ago a patent was taken out by Mr. W. Naylor for an anti-souring tank for the prevention of nuisance in brewery waste.

In the writer's view the exceedingly pungent and offensive odor given off from crude sludge when left to itself is probably due, in the first place, to acid fermentation of the fat present in the sludge. In a tank which had become offensive owing to this acid fermentation, it was found that the fat-splitting organisms did not number more than 10,000 per cubic cm., whereas when the "septic" fermentation was proceeding vigorously about 10 times this number were present. By following the procedure outlined in this paper such acid fermentation is prevented and inoffensive digestion of the sludge assured.

In the paper by the present writer, referred to above, the cost of the process is given as 5d. per ton of wet sludge, containing 90 per cent water, and Mr. John D. Watson, in his paper, read last June, gave his estimate of the cost at a slightly higher figure.

The Human Machine and Its Efficiency

From Engineering and Industrial Management, London, July 1, 1920.

The problem of obtaining increased output from the workers is intimately bound up with the question of the relations of work and wages, and abundant evidence has already been given to show both employers and employed that the scientific organization of labor is advantageous to their general and several interests, and entails no material sacrifice. What is not so clear, however, is the understanding of the physical and physiological elements of industrial work. An understanding of these elements is a valuable guide to the practical application of the researches of those who have been working on the subject of scientific management, and will stimulate further progress in the same field. In "The Motor,"* Professor Jules Amar has brought together in one volume all the scattered and complex elements on which industrial efficiency ultimately depends. His book commences with a short and simple résumé of the general principles of theoretical mechanics which can be applied to the study of the human motor. The laws of thermo-dynamics and of the conservation of energy which provide us with the means by which muscular work and fatigue can be measured are also fully explained; and we are convinced that with a better understanding of these laws it would be possible to appreciate their influence upon industry. The author, who is Director of the Research Laboratory of Industrial Labor at the Conservatoire National des Arts et Métiers, Paris, was appointed by the French Government to investigate the subject of scientific management and industrial efficiency, and the present comprehensive work is the result of his labors. Although published in France in 1914, the present work has only just recently appeared in this country.

The First Study of Labor.—Professor Amar's book serves to remind the student of the fact—often forgotten—that the study of human labor and its mechanical and physiological conditions originated in France, as far back as the year 1785, when Coulomb took the first steps by co-ordinating the physical and biological sciences. Coulomb was the first to investigate the maximum work done in carrying loads. He noted that, if the normal speed of walking was maintained an increase of load caused a reduction in work, and in the daily output. He took a subject weighing 154 lb. who carried a load of 137 lb. for a total distance of 56,758 ft. and obtained as a result:

56,758 (137 + 154) = 16,516,578 ft. pounds (approx.).

It is hardly necessary to point out that the illustrious physicist was in error in this calculation. It is by physiological considerations alone that we can decide with certainty as to the load which causes excessive muscular fatigue. Furthermore, the principles of the science of energy were then unknown, nor had any consideration been given to the waste of energy caused by "static" efforts, or useless movements. Nor was it until M. Chauveau and others of his school, carried out their investigations, that the relations between speed and load conducive to the best results, were understood.

Taylor's Bethlehem Experiments.—It was by these principles that F. W. Taylor was guided in his experiments. In this elementary form of labor the laborer had to stoop to pick up from the ground a billet of iron weighing 92½ lb., to carry it a few steps, and then to put it down. 80,000 tons of pig iron were piled alongside a railway siding. The laborers took the pigs, one by one from the pile, walked up inclined gangways, and placed them in the railway trucks.

At the Bethlehem Steel Works, before Taylor's advent, the output was 12½ tons per man per diem. Taylor increased this to 47 tons per man per diem. Since 1881, while works manager of the Midvale Steel Co., he had made an exhaustive study of the relations between speed and time in human labor. His experiments were conducted thus: He selected two of his best laborers, strong, reliable, and intelligent men. He gave them double pay during the period of the experiments, on the condition that they would, throughout, work their hardest. He also warned them that their output would be tested from time to time, and that any deliberate "slacking" would [illegible] In fact, the men did their best [illegible] In fact, Taylor adopted Coulomb's [illegible] arrived at by Chauveau.

---

*London. Geo. Routledge and Sons, Ltd. $7.20 net.

Under the above conditions [illegible] carried out various tasks. The time taken [illegible] was registered by a stop-watch and [illegible] were carefully noted and recorded. [illegible] could develop from 1/8 to 1/2 HP [illegible] the task on which they were [illegible] to 19,441 ft pounds per diem. There [illegible] to be no strict relation between work and fatigue.

At a later date M. Barth, a [illegible] took up the same study. As a result of numerous [illegible] he formulated his "law connecting work and fatigue." It was found that the actual period during which the laborer was sustaining a load should be approximately 42 per cent of the working day and that for the remaining 58 per cent he should have no load. If "half pigs" weighing [illegible] lb. were carried, the loaded period might be increased to 58 per cent. It was also found that there is a limit to the load which can be carried continuously throughout the day without fatigue.

Chauveau and his pupils, by their experiments on the expenditure of energy, had already arrived at similar conclusions to those of Barth and Taylor. It is clear however, that Taylor was chiefly influenced by Coulomb. He observed indeed, that "static effort" caused muscular fatigue and necessitated intervals of rest. He did not, however frame any general formula for these effects as Chauveau did at a later date.

By careful observation, and by the elimination of unnecessary motions, Taylor obtained important practical results, inasmuch as he increased the daily output per man from 12½ tons to 47 tons. The work done represented the carrying of 1,156 pigs of 91 lb. weight each. The total time under load being 252 minutes out of the working day of 10 hours (600 minutes). The "loaded" time per pig was 13.2 seconds. The laborer walked on the level at 2.72 ft. per second (1.86 miles per hour). He covered 36 ft. per trip—that is, 16.1 miles per day.

This result agrees with Prof. Amar's observations on the carrying of loads of from 99 lb. to 110 lb., by which it was found that willing subjects could cover as much as 18.64 miles at a speed of 4.4 ft. per sec. The short distance of the trip 36 ft. in Taylor's experiments necessarily reduced the speed of walking, although some of the men exceeded the above speed of 2.72 ft. per second and carried as much as [illegible] tons per diem.

These investigations show that under certain conditions, a man can increase his output by due regulation of speed and effort, and by taking definite periods of rest. On the other hand, they reveal the inadequacy of empirical methods based, as in the present case, on what might be described as a "standard laborer."

Taylor should have increased the speed of his men to about 2.8 miles per hour and also increased the number of periods of rest. It should also be noted that, before the pigs were carried, they had to be lifted to the height of the waist, and that they were loaded into a truck reached by a small inclined plane. Also the unloaded return journeys were numerous. Altogether the conditions were different from those of simple transportation, broken only by periods of rest sufficient to restore the vital forces.

Effect of Defective Attitudes in Use of Tools.—In a chapter discussing the relations between the workman and his tools, Prof. Amar describes the effects of defective attitudes in the use of tools. As examples of this he points to the stiffness and clumsiness of the apprentice, faulty positions of the body in relation to the work or tool operated, unnecessary oscillations of the body, or irregularity in the movement of the limbs. We have also to decide, he adds, on the effort, the speed, and the frequency of intervals of rest to be adopted in each particular case. But the useful output of the workman is obviously also largely affected by his equipment of tools, their arrangement, quality and selection.

In fact, the whole outfit of the workshop, both machine and hand tools, should be designed on natural lines so as not to interfere with the speed of the movements, nor cause anything which is not strictly profitable to the work, nor entail interruptions other than those of the rest intervals: the useful efforts must be reduced to a minimum, and useless contractions of the muscles must be suppressed. Thus the transport of goods [illegible] fatigue [illegible]

Steel and [illegible] of the [illegible] in order to [illegible] for the purpose of [illegible]. Taylor applied the same principles in the workshop where [illegible] of a century he [illegible]. Major Frank Gilbreth applied these same principles to bricklayers' work with great success. [illegible] a very complex thing in which numerous factors, internal and external to the workman, have influence. They should never be merely left to chance observation. It demands the method and co-operation of the laboratory and the workshop.

Analysis of Motions.—The author refers to the waste of energy in the workshop which can be removed by methodical organization. "The analysis of motions," he states, "their classification in accordance with their utility, the determination of the suitable speeds for each method and of the best methods in which they can be combined require very special treatment as a department of kinematics. By graphic and chronophotographic methods we can find the path of any moving body and the laws connecting space, time, speed, and acceleration. By these methods we can resolve into elementary motions all the actions of a thoroughly competent workman. Having done this we can observe and eliminate the unnecessary and useless motions which are made by less competent men in carrying out similar work. Such men should be instructed by the exhibition of the results of cinematographic syntheses. In their interests we must co-ordinate science and experiment, figures and facts. For them, instructors must be provided who can intelligently and tactfully combat 'rule of thumb' methods, who can enlist the sympathetic co-operation of the workmen, and demonstrate to them the advantages of scientific methods in industry. Instruction charts would be provided for each class of work, summarizing the results obtained by competent experimentalists. For the sake of the workmen, be they young apprentices or experienced journeymen, the man of science will forsake the peaceful seclusion of his laboratory and will bring to the realm of industry, to factory and to workshop, the marvelous working tools of science which he alone can use—tools undreamt of by the first observers, to whom the human machine was a mechanism working in mysterious and unaccountable ways, in no measure referable to the ordinary laws of mechanics."

Water Waste Prevention

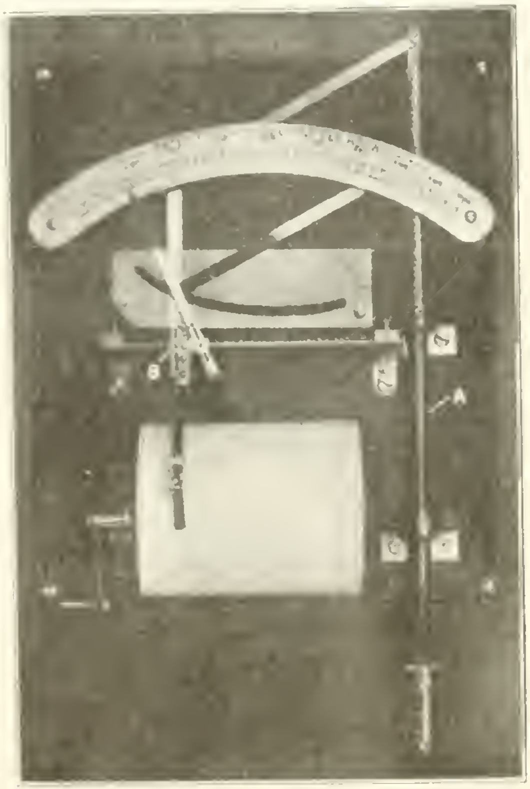
Editorial in Municipal Engineering and The Sanitary Record, London, Aug. 5, 1920.

In these days, when the capital expenditure involved in the extension of water supply undertakings forms such a heavy burden on the ratepayers, it is incumbent on every Water Authority to conserve its present supply to the utmost. The necessity for an increased supply is generally made apparent by the quantity of water delivered through the mains not being equal to the quantity required, or desired to be taken, by the consumers. To increase the quantity delivered from supply means capital expenditure either for the extension of the head works whereby a greater quantity of water is collected, or by duplicating or enlarging the supply main. To decrease the quantity taken by the consumer merely involves, in the majority of cases, guidance by the authorities and the exercise of thought on the part of the consumer, and as the result is an extension of the effective life of the water works without any cost—indeed, probably with a reduction of expenditure, it is obvious that it is a measure of true economy to approach the problem from this side. Most people are careful in the use of water, but there are an appreciable number whose carelessness or deliberate waste increases enormously the amount of water that must be provided. There are many persons who, with the common ignorance of engineering matters, entirely fail to realize that water costs money. A leaking tap may easily waste enough water to supply a hundred people, and if those who waste it do not pay for it, the burden must be borne by all. It will pay an authority to have frequent inspections made of all fittings and to supply and fix new washers wherever they are required free of cost to the consumer.

The Rheograph Water Flow Recorder

From The Engineer, London, July 9, 1920

Although the theory of the flow of water over a V-notch weir is well understood, and the coefficient of the formula connecting the flow with the head over the vertex of the notch known with very great accuracy, the V-notch as a means of measuring the flow of water is unsatisfactory in practice because of the fact that without some artifice the flow cannot be determined by reading it directly against an evenly divided scale. For a right-angled V notch the flow Q in cubic feet per minute is related to the head h in inches in accordance with the formula $Q = .305\, h^{\frac{5}{2}}$. It follows, therefore, that for a given increment of flow the rise of the float measuring the head will decrease as the head increases. If we are seeking to provide a device that will measure a wide range of flows the scale, if graduated in equal increments of flow, will be very open at the beginning, and very crowded in the upper portion. If, on the other hand, we start with an evenly divided scale, one graduation space at the beginning will represent an increment in the flow of a few cubic feet, while an equal graduation towards the end may represent an increment in the flow of several thousand cubic feet.



Rheograph Water Flow Recorder.

Various types of mechanism have been designed with the object of permitting an equally divided scale to be used for reading equal increments of flow. Thus, in one well-known form of recorder a cylinder having a particular form of spiral curve grooved on its surface is used to modify the movement of the recording stylus produced by the float. In the "Rheograph," a new form of flow recorder to which our attention has been called by United Water Softeners, Limited, of Imperial House, Kingsway, W. C. 2, London, the difficulty is surmounted in a novel manner which is both simple and ingenious. The device is arranged to read the flow in gallons per hour against a quadrant scale, and also to record the flow on a chart surrounding a time drum. The chart is 5 in. high and therefore permits a curve to be drawn which is more open than the curves given by some other recorders, wherein the nature of the modifying mechanism restricts the chart height to a certain degree.

At A in the half-tone engraving is shown the vertical rod which, attached to the float, rises and falls with the flow in accordance with the five-halves power law. At right angles to this rod there is fixed a bar whereon there slides a carriage B. The problem to be solved is to devise mechanism connecting the rod and the carriage in such a way that the unequal motion of the rod produced by a given increment of flow will be translated into an equal motion of the carriage, no matter what the flow may be. For example, let the flow increase from zero to 375 gal. per hour. The rod A in this case will rise 1.6 in. Let the flow increase from 3,000 gal. to 3,375 gal. per hour. In this case the rod will rise about 0.17 in. If the flow increases from 6,000 to 6,375 gal. per hour the rod will rise by about 0.12 in. The mechanism to be devised is to be such that each of these unequal movements of the rod is to be converted into an equal of the carriage B—actually a movement of 3/16 in. in the case of the example illustrated in the half-tone engraving.

The mechanism provided consists merely of a parallel linkwork frame and a cam plate. One vertical bar of the linkwork is formed by the upper portion of the rod A. The opposite member, which remains constantly parallel with the rod, is extended and slotted at its lower end to engage a pin on the carriage B, and at its junction with the lower transverse member of the linkwork is provided with a roller which rests within the slot of the cam plate. The essential parts of the mechanism are the rod A, the lower transverse member of the linkwork and the cam plate. If the slot in the cam plate be correctly formed the horizontal component of the movement of the roller in the slot will be proportional to the flow associated with a given position of the float rod A. The other members of the linkwork serve the purposes merely of communicating this horizontal component of the roller motion to the carriage B.

The carriage B is equipped with a stylus, and bears a pin which works within a slot in a pointer swinging on a pivot behind the time drum. The quadrant scale against which this pointer is read is graduated by setting the carriage B into various positions representing known rates of flow. The "Rheograph" illustrated is capable of measuring flow ranging from zero to 10,000 gal. per hour.

Economies in Road Maintenance in Scotland

By JAMES LANG,
County Road Surveyor, Kilmarnock District of Ayrshire.

Paper presented at the annual meeting of the Institute of Municipal and County Engineers at Dundee.

The following notes refer more particularly to work falling directly under the purview of county surveyors, especially in Scotland, where not only the actual road maintenance is carried out, but where—in many counties—the quarrying, breaking and tarring of stone for road purposes is also under the direct administration of the county authorities.

Quarrying and Breaking Road Stone.—While our country has always taken a pre-eminent place in all matters pertaining to road administration, it must be admitted that in recent years the Americans have gone a long way ahead in the quarrying industry. At the present time, in spite of the higher costs ruling in that country, broken stone of excellent quality, well screened and suitable for road work or concrete, is being sold at one-half the price ruling here.

This increased efficiency and consequent cheaper price has been achieved by the introduction of large crushing plants, with jaws ranging from 4 ft. 6 in. by 3 ft. 6 in. to 7 ft. by 6 ft. These plants are capable of breaking up to 500 tons per hour. The stone is lifted from the quarry face by mechanical shovels, entirely eliminating the old method of reducing the stone by hand to a size suitable for feeding into the 20-in. by 12-in. or 30-in. by 18-in. crushers which were formerly used.

A 54-in. by 42-in. American crusher to work in conjunction with a mechanical shovel is at present being erected in Scotland, and it will be interesting to watch what effect it will have in the future development of the quarrying industry in this country.

A central quarry with a railway connection—joint between the Kilmarnock and Ayr districts—has been in operation since 1909. An enlarged plant is meantime in course of construction, and the following description of the equipment may be of interest:

The output will be from 50,000 to 60,000 tons annually. The floor of the working face is 23 ft. below the rail-level at the storage bins. The rock is bored with a rock drill driven by an air compressor. A series of holes are bored 16 ft deep and after charging with explosives are fired by an electric battery. The melled stone is filled into bogies which are hauled up an incline, and after passing over a self-indicating weighbridge are tipped into a 30-in. by 18-in. sledger placed 30 ft. above rail-level—which reduces the stone to 5 in. or 6 in. before passing down a chute delivering into two 21-in. by 10-in. breakers.

The broken stone falls from these breakers into a screen punched with ¾-in. and 2¼-in. holes. The rejections coming out at the end of this screen fall into a 21-in. by 10-in. breaker to be reduced to the required size, and are then elevated, to be rescreened, thus making certain that all the stone has passed through a 2¼-in. hole or less before entering the screens over the storage bins.

The stone which comes through the ¾-in. holes falls into a chute, and is fed into a "dryer," which dries it thoroughly, thus allowing the dust to be properly screened, giving a clean sample of chippings.

The dried materials are elevated into a screen running along the center of the storage bins, where the various sizes—viz., ¼ in., ⅜ in., ½ in. and ¾ in.—fall into separate compartments.

The stone from the 2¼-in. holes in the first screen is also elevated into a screen over the storage bins and divided into 1½-in. and 2¼-in. size.

To meet the ever-increasing demands for chippings for surface tar-spraying, a set of rolls have been put down into which the 1½-in. and 2-in. stone can be run direct from the bins and reduced to the necessary size. The stone, after passing through the rolls, falls into the rejections elevator and is raised into the first screen and thence into the "dryer" as already described.

A dust-extraction plant is also being provided. Looking to the comfort and health of the workmen, this is a necessity, quite apart from the financial benefits accruing from the sale of the dust collected.

The motive power will be derived from electric motors.

The storage bins—of reinforced concrete—are built over the railway and hold about 400 tons, which can be loaded either into railway wagons or into tractors, etc., for local distribution.

The gradients of the railway are so arranged that the empty wagons run by gravity under the bins, and after loading into a siding, where they are picked up by the railway company.

Tar-Mixing Plant.—A tar-mixer running on rails at a sufficient height to deliver the tarred stone into the railway cars, etc., is placed on the opposite side of the bins from the breaking-plant. The mixer can be moved to the various chutes to mix the size of stone required.

The tar is delivered from a railway tar-tank into a storage-tank placed below the rail-level. This tank is heated with steam coils, and the tar is pumped into a tank placed against the wall of the bins above the mixer, where the tar is again heated to the required temperature and delivered by pipes to the mixer.

The stone is measured at the various delivery chutes before entering the mixer, and the quantity of tar required for the different sizes is gaged at a small tank placed on the top of the mixer.

The motor for driving the mixer is attached to it, thus saving shafting and also the time replacing belt when the mixer is moved.

The whole tarring operation is carried out by one man or a young lad at the rate of 15 tons per hour.

Delivery of Tarred Stone.—The handling of tarred stone from railway cars is a source of great annoyance to surveyors. Quite apart from the question of costs, there is considerable difficulty in getting men to stick to the job, and continual changes in personnel have to be contended with.

A proposal is meantime being considered and estimates taken for the necessary plant to handle tarred metal more economically. It is proposed to have iron tipping buckets, each holding 25 cwt., making eight to a railway car load of 10 tons. These will be moved from a movable chute under the mixer, and four can be filled without moving the car. To convey the tarred stone from the railway station to the point of delivery a 5-ton steam car will be employed. This truck will be fitted with a crane driven from the engine, which will lift the buckets from the railway car on to its own body, and also on to the road at delivery point. The buckets will be tapered so as to allow them to be nested for return to the quarry for filling.

Loading Stone Into Steam Trucks.—For county road purposes the 5-ton steam tractor with two 5-ton tipping trailers, one under load and one loading, has been largely used. Recently 5-ton steam trucks fitted with rubber tires have become popular, owing to their increased speed, but this saving is counteracted by the delay in loading. To obviate this, a 5-ton loading bin is meantime under construction for use in this district. The bin will be mounted on wheels for transit, and fitted with an elevator driven by a 1½ HP. oil motor for raising the stone either from a heap or from a railway car into the loading bin.

The following statement shows the present tonnage hauled daily and the cost, and also the estimated tonnage and cost when using a loading bin.

Working without loading bin.

5-ton steam truck hauling 3 miles from loading point. No. of trips 4.

Time of loading four loads	180 min.
Delivering load and returning four trips	240 min.
	420 min. (7 hours)

Cost:

	£	s.	d.
Two men loading	1	0	0
Driver and attendant	0	19	8
Coal, etc.	0	7	0
Repayment of capital and depreciation of wagon, say	1	0	0
Total	£3	6	8

20 tons at 3s. 4d. per ton equals £3 6s. 8d.

Using loading bin.

Same distance. No. of trips 7.

Time loading seven loads	35 min.
Delivering load and returning seven trips	420 min.
	455 min. (7 hr. 35 min.)

Estimated cost:

	£	s.	d.
Two men loading	1	0	0
Driver and attendant	0	19	8
Coal, etc.	0	9	0
Oil for motor	0	3	4
Repayment of capital and depreciation of wagon, say	1	0	0
Repayment of capital and depreciation of loading bin	0	18	0
Total	£4	10	0

35 tons at 2s. 7d. per ton equals £4 10s.

By adopting the foregoing, or some other method of speeding up loading, not only will the cost of haulage be reduced, but the increased quantity of stone delivered will enable one wagon to keep a road roller in full work instead of two.

Surface Tar-Spraying. The tar-spraying of roads, especially in populous areas, is always a source of annoyance and discomfort, owing to the difficulty in keeping pedestrian and vehicular traffic off the newly tarred surface until it has been covered with chippings.

Several methods for carrying out the spraying and chipping in one operation have recently been introduced, and their use has been very much appreciated by the public.

The system adopted in the author's district is as follows: A 5-ton tractor hauls a 320-gal. tar tank, to which is attached a 5-ton tipping wagon filled with chippings. A flexible pipe is led from the tar tank and coupled to a sprayer fixed to the bottom of the wagon and behind the rear wheels. A V-shaped trough is placed under the back door of the wagon. The opening in the bottom of this trough can be regulated to suit the size of chippings in use. To prevent choking, a tube or shaft with projecting spikes driven by a chain from the hub of the rear wheel runs through the trough. A 6-ton load of chippings covers from 700 to 800 sq. yd., or 350 to 450 lin. yd. of 2 yd. wide, and the spraying and chipping is carried out at a speed of 4 miles per hour.

Apart from the saving in labor, which is considerable, the chippings are spread more uniformly than can possibly be done by hand.

Power from the Tides. The industrial utilization of tidal power is shortly to be put in operation at La Landriais, near St. Malo, on the River Rance. The scheme depends on the construction of four basins at different levels, each being used for power generation at different states of the tide, according to a cycle based on the Decoeur cycles described before the Academie des Sciences in 1901. The four basins will have an aggregate area of some 50,000 acres, and it is estimated that turbines worked by the passage of water into and out of these basins will give 5,000 H.P. at neap tides and ten times more at springs. The engineers responsible for the undertaking are M. de Tregonain and Parisot and Maire.—The Times Engineering Supplement, August, 1920.

Utilization of River Water for Compensation Purposes

By WILLIAM TERREY,

General Manager, City of Sheffield Water Department.

From the Surveyor, London, July 9, 1920.

The unique proposal of Sheffield to utilize river water for compensation purposes, which received the assent of Parliament, deserves the careful consideration of water authorities and all who are interested in the question of economizing the water and financial resources of the country. Under the provision of local Acts passed in the years 1853 and 1867, Sheffield is under obligation to discharge into the rivers Rivelin and Loxley an average quantity of about ten million gallons per working day as compensation water, which represents 51.7 per cent, or rather over one-half of the average available yield of the watershed, leaving 48.3 per cent for town supply.

In those early days the law of rainfall was not as well understood as it is today. There were no actual measurements and observations extending over many years, and therefore no sufficient or reliable data upon which to arrive at accurate conclusions as to the total collectable rainfall. The result is that the Rivelin and Loxley mill owners received about 3¼ million gallons per day in excess of the recognized proportion of one-third now usually required by Parliament for industrial areas.

This 10 million gallons of moorland water sent out of the reservoir is polluted within about 400 yards of the mill gauge by the discharge of acidic ochre water from Ganister Mines, and below that point down to its junction with the River Rivelin and its passage through Sheffield is further polluted at frequent intervals by the discharge of trade effluents, and to feed the river with a large quantity of costly water, of a high degree of purity, seems a waste of valuable resources.

The River Don is largely used for certain types of boilers, condensing, operating water wheels for power, grinddstones, cooling, quenching, and various works purposes, but in its present ochrey and polluted condition it is totally unfit for boiler feed, and most of the manufacturers who make use of it for this purpose are compelled to install special softening plants.

The corporation voluntarily discharge from their Blackburn sewage works into the River Don, 1¼ miles above the site of the proposed intake, an average quantity of about 21 million gallons per day of sewage effluent. This effluent is the property of the corporation. The riparian users and mill owners have been recompensed by the construction at great cost of impounding reservoirs from which the compensation is discharged in a regular and uniform flow.

The scheme in outline submitted to Parliament was to retain the pure water in the reservoir for the domestic needs of the city, and, in lieu thereof, to abstract and pump back such daily quantities of river water as may be required from time to time up to a maximum of 10,000,000 gal. per working day, at a point about one mile below the city boundary, to a site adjoining the sewage works, purify and soften it, so as to conform to the standard set out in the Bill. The filtered water will then be pumped back upstream by means of high-lift pumps through a 26-in. main laid along public roads and existing easements (a distance of about 11 miles), into a balancing tank to be constructed at the foot of the Damflask embankment, and from thence discharged as compensation water over the statutory hill gauge in substitution for an equivalent quantity of pure water now sent out of the reservoir. The lift including friction, is from the low-lift to the high-lift station 71 ft., and therefrom to the balancing tank at Damflask 285 ft.

The object of this reuse of the river water is to rescue a valuable supply of good water from wasteful discharge into a polluted river and utilize it for the domestic requirements of the district. In other words, a portion of the river water will do double duty between certain points, by reserving for town supply water which is fit for town supply, making good that which is taken away by the substitution of treated river water suitable for industrial purposes.

It was submitted that, although it was in the nature of an experiment, and the first attempt of the kind made in this counry to utilize compensation water for domestic use, it embodied a valuable economic principle, and should be applied if it could be shown that the substitution could be effected to the great advantage of the community, and without endangering public health or doing any real injury to any interests involved.

Psychology and Industry

From The Times Engineering Supplement, London, August, 1920.

The Engineering Supplement has often drawn attention to the wide field that many problems of industry present for exact psychological investigation. During the past year, however, it has been compelled more than once to point out that psychologists seem disposed to go beyond exact investigation, and to claim in industrial matters an authority that, so far as can be judged by any evidence yet produced to engineers, does not fall within the scope of their science.

Experimental Psychology.—The subjects on which psychologists can both claim pre-eminent ability to help industry and can produce high credentials of competence are those that can be investigated by the methods of experimental psychology. The conservation of movements, the factors of fatigue, the length of hours of work, the effect of rest and selection of rest-pauses, the choice of occupations, and the selection of workers are all examples of problems to which these methods appear to be immediately applicable.

Yet as a matter of historical fact psychologists do not seem to have been the first to make successful investigations of these problems. In conservation of movements, for example, the work of Taylor and of F. B. Gilbreth appears to have been done without any conscious reference to the methods of experimental psychology. Nevertheless an examination of the elements of these problems shows that they are precisely similar to those on which experimental psychology has now been working for many years; and even if no other evidence were available, it would be obvious that work of this order, involving as it does exact measurement of motions and reactions and other processes of men's nervous systems and minds, is likely to be done better by those who are in the habit of making such measurements, and have been trained in the technique and practice of the observations involved, than by those who have no such methods at command or to whom they are unfamiliar. But this presumption has been widely tested in actual practice. During the war, for instance, the examination of recruits for the Air Service appears to have been made largely on data obtained by methods of experimental psychology applied, and in many instances devised, for that purpose, and the results of the selection so made were found thoroughly trustworthy. In the United States, where the relatively small proportion of men required for military service allowed a far greater discrimination to be exercised than was possible in this country, psychological methods were used with very satisfactory results for the selection of recruits and the allocation of their work. Even in some industries it has been found possible to grade applicants for work according to their response to psychological tests in such a way as to indicate their relative fitness for particular jobs, and thus avoid the disadvantages of the ordinary method of "hiring and firing," or, more gracefully expressed, trial and error.

Industrial Psychiatry.—A paper by Dr. Southard which the Engineering Foundation in the United States has recently published makes the remarkable suggestion that a practicable and effective method of improving the "mental hygiene" of industry would be to attach to each works or group of works a psychiatrist or physician of the mind, who by timely and appropriate treatment of "psychopaths or near-psychopaths" would decrease unemployment and industrial unrest and improve the standard of "industrial mental hygiene." Neither the physician of the mind nor the average American technical writer is credited with a genius for accurate classification. They are thought to be a little too apt to make fresh classes for inconvenient exceptions without a sense either of the ridiculous or of the rules of scientific classification. But it may be questioned whether they have ever produced anything more notable in the way of reckless classification than the list of types under which candidates for psychiatrical examination may be divided. This remarkable list is quoted by Dr. Southard from the work of Dr. Jau Don Ball, of Southern California, whose methods he commends as scientific aids to industrial efficiency and practical aids to industrial welfare. It runs, verbatim, "Queer guys, eccentrics, disturbers, querulous persons, unreliable and unstable fellows, misfits, the irritable, the sullen, socially disgruntled, unsociable, negative, conscientious, litigious, bear-a-grudge, peculiar, glad-hand, gossipy, roving, restless, [illegible] swaggering sex pervert, false accuser, [illegible] susceptibility and mental twist types." There are [illegible] conditions that can be treated and relieved [illegible] and in default of such treatment [illegible] But a list such as this amounts [illegible] industry as a vast asylum for the [illegible] One shudders to think how many of [illegible] recognized by a zealous psychiatrist [illegible] the House of Commons, or even the [illegible]

Mental Hygiene of Industry.—It [illegible] Dr. Southard is right in suggesting that a [illegible] consultant might be useful to a [illegible] insights of vocation and troubles of [illegible] nite program and more intelligible [illegible] should be given in support of what after all would [illegible] experimental departure. The proposal is put forward as part of a [illegible] of measures for promoting the "mental hygiene of industry." These are suggested as helping "to [illegible] for individualism in industry, and [illegible] the assumption that psychiatrists are the [illegible] "experts in grievances" and the best [illegible] temperament. The promotion of mental hygiene is compared with the public health service, and from the fact that public health is taking increased account of personal hygiene it is inferred that the time is now ripe for it to include in it [illegible] mental hygiene. The subject is said to be engaging the attention of the American National Research Council on the suggestion of the Engineering Foundation, and a committee has been appointed to "consider the scope of investigation into industrial personnel."

A Confusing Analogy. What appears to be confused and confusing in the view of industrial mind troubles here presented is that while they are exhibited as inherent in the individual and to be treated in individuals they are compared with the public health service, of which, though care of the individual is included in its duty, the most important function is the recognition of the source of infection and its segregation and disinfection. It is obvious that if the individual patients become socially disgruntled or conscientious or bear a grudge through contact with some common focus of infection external to their shop or the industry, the proper treatment must include recognizing and attacking the external focus of infection and if possible sterilizing it. The treatment of individual cases is by itself an insufficient measure for abating a widespread infection.

This may perhaps account in part for the fact, recorded a little while ago by Mrs. Brierley in the British Journal of Psychology, that widespread opposition exists among organized labor to the introduction of psychological methods into industry. The anti-social movements by which industry is often rent may undoubtedly be regarded as diseases; but any scientific movement for abating them must lead to sterilizing the original sources of infection. It is not unnatural that the small but intelligent minority that speaks in the name of organized labor, like the intellectuals by whom this minority is inspired, should object to a movement which, if applied honestly and logically, must remove much of their present power for what industry regards as mischief.

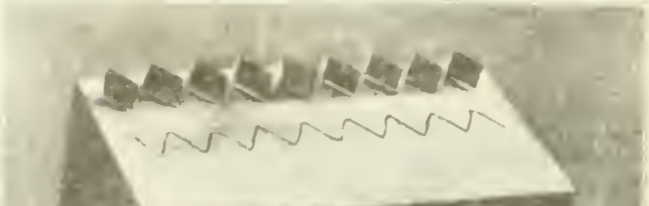
Psychology and Economics.—The determining factor in deciding whether industry should invoke the aid of the psychologist is, however, not whether organized labor or organized capital likes his methods, but whether his methods will make industry more efficient. In this country there have been unmistakable indications that some psychologists conceive themselves to have a mission for "undertaking to reform industrial method." What they do not seem to realize is that, to be satisfactory in the long run to any party, industrial method must promote industrial efficiency. Mrs. Brierley, for instance, attributes the opposition of workers to psychological methods partly to suspicion of employers and fear of unemployment and partly to the fact that "the workman, stimulated by the growth of political democracy and by a measure of education, has arrived at and holds firmly to a conception of his own human dignity and of the basic value of human personality," which are endangered by the monotony, loss of craftsmanship, and absence of creative work involved in efficient manufacture under the guidance of psychological results. These objections may be perfectly just, but they do not alter the fact that the population of the world can live and gratify its material needs only by working to the best advantage, and that far more inexorably than the Ap[illegible] economic nature [illegible] that if an industry [illegible] work [illegible] effective [illegible] way.

In recent literature psychologists [illegible] industry [illegible] What is wanted is not the theories of psychologists or [illegible] of industry and the methods by which [illegible] duty of those who practice it may be [illegible] the plain and uncolored statement of the psychological facts they are able to measure. If on the other hand psychology has data that go beyond what at present are understood to be its boundaries, and is truly able to announce [illegible] results in what hitherto has been regarded as the subject matter of ethics or economics, the industries by which it wishes to be consulted are entitled to ask for an accurate statement of the suggested extension of its scope, and the credentials that warrant its claim to the extension.

Device for Preventing Cracking of Railway Ties

From Indian and Eastern Engineer, Jan., [illegible]

The tendency of railway sleepers to crack at the ends is well known to engineers and is especially noticeable in hot countries where damp wood dries so rapidly on the surface before the interior has lost its moisture. There is thus irregular shrinkage causing cracks that begin on the surface and often penetrate to the center. The drying and shrinkage are most rapid at the ends of the wood, especially when stacked with the ends exposed, as water vapor escapes most freely from the ends of the pores. Shrinkage then takes place over the whole surface of the end while at a short distance along the wood shrinkage has hardly begun, the result being a rupture of the outer surface that may travel a considerable distance along the wood.



Chotani Device for Preventing Cracking of Ties.

Attempts have been made to stop cracking in the ends of sleepers by means of a ⅝-in. bolt fixed in both ends. If placed in dry sleepers and screwed tight, the first heavy rains will moisten and swell the wood around the bolts, not to its full size when wet, but sufficient when dry to leave the bolt slightly slack, and if not promptly attended to, the wood is in a state to crack at the next wetting. The bolt is thus only a partial remedy besides adding considerably to the cost of the sleeper. It was this difficulty that suggested the invention of Chotani's railway sleeper tie, a recent patent. It consists of a ribbon of steel or iron bent to a zigzag form and forced into the end of a sleeper, where it forms an elastic tie that, while following the movement of shrinkage and expansion across the grain, keeps the fibers always together, so that whether the movement is due to sudden soaking and drying or the slower process of shrinkage due to age, cracking is avoided. The illustration shows the end of a sleeper with the Chotani tie imbedded in it and binding the whole width of the sleeper. It has the following advantages.

It does not attempt to interfere with the natural movement of the wood under the influence of the weather.

It is much cheeper than the bolt, especially at the present price of metals and it dispenses with a special machine for boring holes.

It may be applied in the forest to newly cut sleepers protecting them against cracks while drying or while lying in store and it reduces the risks of rejection by inspectors.

It cannot be stolen once put in place, and the ties themselves have very little value except when applied to their proper use. This cannot be said of the bolts.

The Baghdad Railway

From Engineering, London Aug. 6, 1920.

To the public, the title "Baghdad Railway" has always been misleading; suggesting a complete new scheme for a line from Constantinople to Baghdad; whereas the line of the Anatolian Railway reached as far as Konia, the old Ottoman capital, before the extension to Baghdad was contemplated. At the time of the armistice, in 1918, the Anatolian Railway was completely separated from the Baghdad system, for which the British War Office appointed a controller-in-chief, to organize and control the whole line from Konia to Baghdad.

The Pan-German conception of Eastern expansion had, as its principal idea, this trunk line towards the Persian Gulf. The history of the project, and its great political, financial and especially engineering difficulties, not only under German management, but under the subsequent direction of the Allies, will provide, in the future, a rich field for reference and comparison, in all similar undertakings. The scheme was a pet idea of the German Kaiser, who took a keen personal interest in it, and even went so far as to order the construction of a special train to convey him to the opening ceremony at Baghdad, which it was assumed would take place in 1918.

Fig. 1—Temporary Road, Taurus Tunnel Section.

In 1903 the Ottoman Government granted a concession for construction, to a group of financiers, headed by the director of the German Bank, von Gwinner. The Ottoman Bank in Paris was also largely interested in the project which, as a commencement, only contemplated the construction of 200 km. of line from Konia to Bourgoulow. For this a construction committee was formed, and the work completed by the end of 1904. It was not till 1909 that the Ottoman Government agreed to the construction of 800 km. of line, up to Tell-Helif, near Nisibin. In this year a new construction committee, under the title "Societe Pour la Construction des Chemins de Fer de Turquie," was created by the Baghdad Railway Co., with headquarters at Glarus, in Switzerland. A board of 12 members was appointed to control the new construction, and consisted of five German members, four French, two Swiss and one Austrian. The Baghdad Railway Co. defrayed the cost of the construction, 9 per cent being alletted as profit to the construction committee. The offices of this committee were in Frankfurt-on-the-Main.

Three divisions were created in Turkey under the direct supervision of the Frankfurt committee. The divisions were as follows: No. 1, from Bourgoulow (km. 200) to Dorak (km. 329), comprising the Taurus Tunnel sections, which formed the most difficult and important part of the whole undertaking. This was placed in the hands of Mr. N. Mavrogordato, an engineer of international repute, and wide experience.

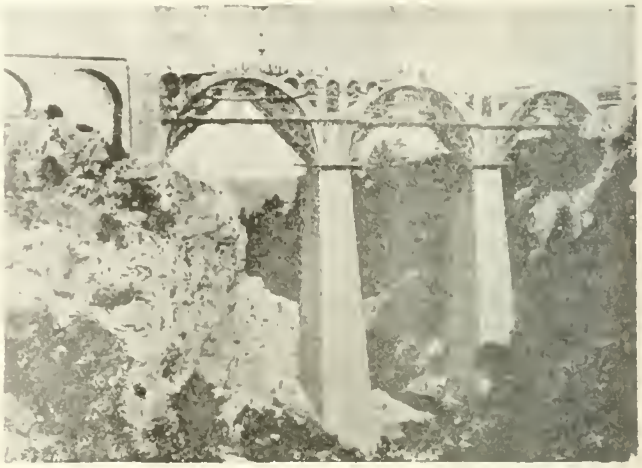


Fig. 2—Hadji-Kiri Viaduct Under Construction.

No. 2 division was from Dorak (km. 329) to Islahie, in the Amanus Mountain range. This included a large bridge over the river at Adana. It also included many tunnels through the Amanus range, the longest of which measured 4,902 m. The chief engineer was Mr. H. Winkler.

No. 3 division extended from Islahie to Tell-Helif, and comprised the Aleppo division. Near Aleppo a steel viaduct was constructed, 800 ft. long, 450 ft. high; a very graceful, but apparently very light structure. In this division was also the great bridge over the Euphrates at Jerablus, with 10 spans of 165 ft. each, and a total length of about ½ mile.

Later on, a fourth division was made at Baghdad, after the Turkish Government had consented to the construction of the line as far as that town. The chief engineer of this division was Merione Pacha.

Until the Balkan War of 1912, the work progressed very well. Up to this time, two issues only of the Baghdad Loan had been made, or about two-fifths of the entire sum. Subscribers were, however, not to be had for the third issue in 1912. Lack of money prevented the construction committee from carrying on the works at the former speed; and this financial difficulty continued up to the outbreak of war in August, 1914. Nearly all the works were then stopped, with the exception of the Taurus and Amanus tunnels, and the great Euphrates Bridge. When the Turks, at the end of 1915, came into the war, the German Government, realizing the importance of this railway for carrying on the campaigns in Asia Minor and Mesopotamia, made the Turkish Government come to an agreement with the Baghdad Railway Co. to continue the works, and complete them as quickly as possible. The Turkish Government did not want a Decauville line to be built first, but wanted the broad gage (4-ft. 8½-in.) construction pushed as soon as possible, through the Taurus and Amanus ranges to Aleppo. All the expenses, as long as the war lasted, were to be refunded to the Baghdad Railway Co., with a percentage for the committee, without the limit laid down in 1909. This contract between the Turkish Government and the Baghdad Railway Co. did not meet with the approval of the German Army Headquarters Staff; which made a new contract with the company, by which the German Government undertook to furnish all the money required, as a loan to the Turkish Government, and thus guaranteed the payment of the money for building, and the percentage [illegible] the Turkish contract. It was insisted, however, that the work should be pushed on in such a way that a narrow-gage railway (60 cm.) should be laid right through as soon as possible and that the broad gage should be [illegible] after the narrow gage had been made fit to [illegible].

These narrow-gage lines through the Taurus from Karapunar to Dorak, and through the Amanus to Islahie were completed by the beginning of January, 1917. They made a very great difference in carrying on the war in Mesopotamia and Palestine. By transferring only [illegible] it was possible to convey war stores and material to both the fronts by rail, whereas previously motor and horse transport had to be employed, over dangerous and precipitous roads and tracks.

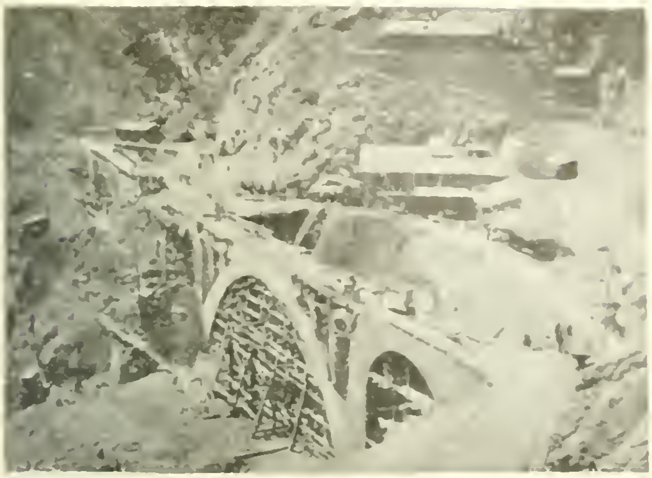


Fig. 3—Typical Connecting Bridge on Taurus Tunnel Section.

The broad-gage line was only finished on the Taurus Tunnel section on Oct. 5, 1918; and as the British occupation of Aleppo was effected on the 24th of the same month, the Turks and their allies gained little benefit from this great engineering feat, to the completion of which some thousands of British and Indian prisoners-of-war had contributed, under conditions which, to say the least, left much to be desired.

The following details show the progress and position of the undertaking, to date: The distance from Konia to Aleppo, which is the junction for Palestine and Egypt, is 766 km. From Konia to Nisibin, which is at present the furthest railhead towards Baghdad, is 1,101 km. To Mosul up to which the earthworks are completed is 1,700 km. to Baghdad the total distance is 1,749 km. The railway has been constructed from the Baghdad end, northwards, as far as the oilfields at Shargat, so that only a gap of about 175 miles or about 280 km. remains to complete the through communication between Baghdad and Constantinople.

Permanent Way.—The rails are 37.42 kg. per metre, and the line is a single track gage 4 ft. 8½ in. The Taurus summit is 1,468 m. In the Taurus division there are 36 tunnels in 62 km. In the Tarus Tunnel section proper there are 11 tunnels, of an aggregate length of 10,036 m., the longest being 3,795 m. Near Bagtche, in the Amanus, there is the long tunnel, already mentioned, of 4,902 m., with a summit level of 741 m. The minimum curvature is 400 m. radius, or about 4° 30'.

Grades.—In the first 210 km. from Konia the grades do not exceed 1 per cent; but on the ascent to the Taurus summit, there are 13 km. of 2½ per cent, and on the descent there are several short lengths of the same grade, extending over a section of 45 km. A second section of 50 km. near the Amanus mountains has also grades of 2 per cent and 2½ per cent. Between Aleppo and Nisibin the grades do not exceed 1¼ per cent. Owing to these abnormal grades, the working of this part of the line is difficult, and not economical. A much better line could have been located nearer the sea, avoiding the Amanus range; but this was not done, for strategic reasons.

Telegraphs.—There are four lines for the whole distance, and telephone in addition.

Workshops and Sheds.—The main workshops are in Konia, Adana and Aleppo. There are roundhouses at Karaman, Eregli, Adana, Mamoure, Alexandretta, Mouslimie and Aleppo and smaller engine sheds at Bozanti, Tarsus, Toprak Kale, Meidan Ekbez, Tel Abiad, Ras el Ain and Nisibin.

Stations.—There are [illegible] stations, an average distance apart of 16 km. They are built of dressed granite, [illegible] rock, and are of excellent construction.

Rolling Stock.—The locomotives are all of German heavy type construction, which is necessitated by the heavy grades. The coaches and wagons are of the latest bogie type.

Traffic Capacity.—The traffic capacity is eight pairs of trains per day between Konia and Aleppo, eight pairs of trains per day between Aleppo and Ras el Ain, four pairs of trains per day Ras el Ain and Nisibin.

Figure 1 is a view of the temporary road used in the construction of the Taurus Tunnel section. 5,000 men worked a year to complete this road. Fig. 2 is a view of the Hadji Kiri Viaduct, 600 ft. long, 160 ft. high. This was to have been constructed of light steelwork, but as that material was not obtainable during the war it was decided to construct it in ferro-concrete. No scaffolding, only centering, was used, all material being carried and placed by an air line. Fig. 3 is a view of one of the typical connecting viaducts between the tunnels of the Taurus Tunnel section.

When taken over by the British control absolute chaos prevailed on the railway. Much damage had been done to the permanent way, buildings and rolling stock. The Taurus Tunnel section needed completing, as the tunnels were unlined, while the permanent way, cuttings and banks were unfinished, and were not safe for traffic. All this work was put in hand at once, and was carried out chiefly by the Indian sappers and miners, who did most excellent work under very trying climatic conditions. That the railway, under efficient management, has a favorable future, financially, is shown by the fact that, after payment of all construction and running expenses, during the first year that the line was under British control, a net credit balance of 250,000 L. was obtained.

Uses of Timber

Extracted from Engineering, London, July 9, 1920.

Engineers and architects are not unnaturally averse from risking their reputations by specifying comparatively new and untried materials for the structures for which they are responsible, but circumstances frequently arise in which their natural inclinations are set aside by exceptional conditions. During the war, a shortage, or the complete absence, of a certain material often rendered the use of a substitute necessary, and considerable resource was displayed in applying such materials as were readily available to uses for which they had not been previously employed. In certain classes of timber used in aircraft construction the shortage was acutely felt, and, consequently, such varieties as were obtainable were employed for purposes for which they would certainly not have been specified in pre-war days. A similar state of affairs, of course, existed with other materials, but it is with timber that we are mainly concerned at the moment, since the shortage resulting from excessive war demands cannot be so readily made good as can a shortage of manufactured materials.

Although the forests of the British Empire must contain timber of every possible quality in quantities more than sufficient to supply our whole requirements, it is a fact that, for the five years preceding the war, about 90 per cent of the timber imported into this country was of foreign growth. There can be little doubt that this unsatisfactory state of affairs was largely due to the fact that timber users were not sufficiently familiar with the properties of timbers grown within the Empire, and for this reason we welcome the efforts made by the Department of Overseas Trade to provide the necessary information. With this object in view they have organized the Empire Timber Exhibition. Here are shown an almost bewildering variety of timbers grown in this country and in the Overseas Dominions. Space will not permit us to deal exhaustively with all of them, but we wish to call attention to those varieties of timber grown in the Overseas Dominions which are suitable for engineering work and are also available for export to this country.

Canadian timbers, of which 25 varieties are exhibited, are perhaps better known in this country than those of some other Dominions. Among them may be mentioned Western hemlock, against which some prejudice appears to exist on account of the poorer qualities of Eastern hemlock. It is, however, a useful timber for structural work, being both lighter and harder than Douglas fir, but not quite so stiff. Another Canadian timber known as Western cedar, has exceptional powers of resistance to rotting in a damp, humid atmosphere, and on this account has been satisfactorily employed for the roofs of weaving sheds, pulping houses, and other buildings in which excessive humidity prevails. A section of roofing suitable for such structures is shown composed of an internal layer of Western cedar separated from the outer boards by three thicknesses of tarred paper. Over the outer boards, which are of common pine, creosoted, is a covering of tarred felt and over this is a layer of pitch and gravel. Such roofs are, of course, somewhat expensive in first cost, but they have the advantage of great durability, and they can also be painted internally, which cannot be done if creosote is used as a preservative. Wooden continuous-stave pipes, which may be constructed of Douglas fir, have considerable advantages in the matter of transport in comparison with steel pipes, and are claimed to be just as durable. Wooden spigot and socket type pipes, wound with stout wire, are also made for underground water supplies and examples of these are included in the exhibit of the Canadian Government.

The eucalyptus and turpentine timbers of New South Wales produce many hardwoods for bridge work, and street paving, and also for the construction of heavy transport vehicles. The varieties available for export include iron bark, which is excellent for piles and also for the spokes, hubs and felloes of wheels. Blackbutt and tallow wood are also useful for marine structures in that they resist the attacks of boring organisms such as the teredo. Blackbutt is also used for the scantlings of railway wagons and ironbark, above referred to, is employed for the arms of telegraph posts on account of its great strength and good weather-resisting properties. The karri and jarrah of Western Australia are, of course, well known in this country, where they are largely used for street paving.

A useful timber known as watercare, comes from Trinidad. Watercare, or guatecare, is a hard, heavy wood, somewhat difficult to saw and plane, but it is very durable in all situations and is not attacked by insects. It has been largely employed locally for posts and also for piles driven into the ground. For piling it is said to be cheaper and to stand heavier driving than greenheart, and as plenty is available for export it is certainly worthy of the attention of engineers. It is obtainable in lengths up to 30 ft. and up to 16 in. square. Two varieties of mora, red and white, come from British Guiana and Trinidad. The white variety, however, has a bad reputation, having proved unsatisfactory in the dykes of Holland, although the red variety is said to be quite suitable for harbor works and marine structures generally; red mora is also useful for the construction of railway wagons. In general it may be said that the timbers of British Guiana are similar to those of Trinidad, but the supply available in the former country is practically unlimited. A variety of British Guiano timber, known as monkeypot wood, is claimed to be one of the best and strongest woods for wheel spokes, and also to be useful for piles. That country also produces a light timber called ciroubaili, which resembles satin walnut, and is useful for building construction, although extreme durability cannot be claimed for it.

Another timber which appears likely to be useful for engineering work is a variety of ironwood which comes from British East Africa, and is known as musharage. It is hard, heavy and straight grained, is easily worked, but does not take nails well, and neither is it resistant to the attacks of insects. It can, however, be used for railway ties and is excellent for cart and wagon building. Mweri, another East African timber of somewhat similar characteristics, is also available for export in moderate quantities. For piling and marine structures, a timber known as ekki, grown in the swamp and rain forests of Nigeria and the Gold Coast, may be largely employed when it becomes better known. It is very heavy, hard and durable, has a high tensile strength (16,000 lb. per square inch, in the direction of the grain), has exceptionally good weather-resisting properties, and, for marine structures, has the advantage that it is not attacked by the teredo. Ekki has been largely used in Nigeria for the construction of wharves and jetties exposed to salt and brackish water, and as it is available for export, it might well be tried in other countries. It would also appear to be quite suitable for street paving blocks and has already been employed for mine supports and brake blocks.

Laboratory and Practical Experiments in Preliminary Treatment of Sewage

By JAMES H. EDMONDSON.

Paper read July 10 at annual convention of the Association of Managers of Sewage Disposal Works.

In the purification of a town's sewage the separation of the solids from the liquid, or, as it is usually termed, the preliminary treatment of sewage, is an important factor when considering the secondary treatment i. e., the filtration of the resulting liquid either by means of land or artificial filters.

The absolute separation of the solids from the liquid is an ideal which is not economically attained in practice, but varying degrees of such separation can be obtained by various methods of treatment. In some cases the sewage is simply settled in tanks, as, for example, the systems known as sedimentation and septic treatments, while in others chemicals are added prior to the settlement to aid in the separation. The choice of chemicals when considering chemical precipitation is an important one, and the experiments to be described are entirely in connection with this method of treatment, although some of the derived conclusions are applicable to all methods of tank treatment. Various chemicals have been tried as precipitants, but the most successful have been proved to be lime and salts of iron and aluminum, used either separately or conjointly, the choice being dependent upon the character of the sewage treated, together with the price of materials used and facilities for transport.

The action of the iron and aluminum salts—usually the sulphates—are very similar. On coming in contact with the sewage, which is usually alkaline, the hydrates of iron and aluminum are formed, and in settling mechanically aid the separation of the finer particles of solid matter; they are also assumed to have a clotting action on the colloid matter present.

The higher the degree of purification obtained by the preliminary treatment the less area of land or cubical capacity of filters is required, and in considering the increased cost due to the addition of chemicals, the consequent reduction in capital costs must receive attention.

Sewages vary very greatly in character, and in order to find which is the best and most economical precipitant to use for any particular sewage it is important for each works to carry out its own experiments and analyses.

The Southall-Norwood sewage works, of which the author was manager prior to his present appointment, had for many years used lime and sulphate of alumina with excellent results. Ferric sulphate, however, was a much cheaper product, and it was thought desirable to determine whether the latter could not be substituted, so as to reduce costs without affecting efficiency. With this end in view, samples of the various precipitants, together with quantities of the average crude sewage, were submitted to various analysts, who carried out laboratory tests on them, and in nearly every case reported in favor of ferric sulphate. On the working scale it was found that these results were not confirmed, and that the effluents resulting from the different stages of the purification were not up to the standard of those previously obtained.

On the author's appointment as manager and chemist to the above works, he was asked to pay particular attention to the question of precipitants, and in conjunction with the late engineer to the council—Mr. Reginald Brown, M. Inst. C. E.—carried out working-scale experiments, the results of which were embodied in two papers presented to the Society of Engineers.*

The experiments briefly described later, with the average results obtained, are a "précis" of these two papers, the later experiments being the outcome of the comparison of such results with those obtained from laboratory experiments.

In order to make the results comparable, either the cost or the efficiency must be reduced to a standard, and as the former was the simpler, the basis of the old working was adopted viz., 1.90 grains per gallon aluminium sulphate, plus 2.80 grains per gallon lime, calculated on the dry-weather flow.

---

*"Proceedings," Soc. Eng., March, 1916, and November, 1917.

The quantity of ferric sulphate [illegible] the same cost was then determined [illegible] grains per gallon.

Both precipitants were analysed [illegible] pared below

	[illegible]	[illegible]
Insoluble in water	[illegible]	[illegible]
Ferric oxide (Fe_2O_3)	[illegible]	[illegible]
Ferrous oxide (FeO)	[illegible]	[illegible]
Alumina (Al_2O_3)	[illegible]	[illegible]
Combined [illegible] (expressed as [illegible])	[illegible]	[illegible]
Free sulphuric acid	[illegible]	[illegible]
Free and combined water [illegible]	[illegible]	[illegible]

In valuing a precipitant the [illegible] to represent its worth. In the [illegible] that the ferric sulphate contains [illegible] oxides, as against 14.8 per cent [illegible]. The prices at the time of the experiment [illegible] per ton respectively, so that [illegible] ferric sulphate to be superior unit for unit [illegible] a cheaper product.

The experiments undertaken were:

(1) The addition of ferric sulphate to the sewage at the rate equivalent to 4 grains per gallon, calculated on the dry weather flow.

(2) The addition of 2 grains per gallon of ferric sulphate plus 2 grains per gallon of lime, calculated on the dry weather flow.

(3) The addition of 1.9 grains per gallon of aluminium sulphate and 2.8 grains per gallon of lime, calculated on the dry weather flow.

For the purpose of the trial the whole works was converted into an experimental plant, and each experiment was run for a period of 14 days. Before the commencement of each experiment all the deposit in the tanks was thoroughly cleaned out. In all cases the chemicals were roughly added in proportion to the strength and quantity of sewage delivered at the works each hour, and recorded such as aerial nuisance, the appearance of the sewage during its various processes of purification, the ease or difficulty of dehydrating the deposit left in the tanks commonly known as sludge, the appearance of the surface of the filters for growths, ponding, etc. The samples were taken every hour, and averaged for the 24 hours in proportion to the flow. In each of the three experiments eleven full analyses were undertaken, the average of the results being given in Table 1.

During the period Experiment 1 was being undertaken the physical conditions of the sewage were noted during its various processes of purification. The effluent leaving the precipitation tanks was invariably of a dark color, and, if kept stagnant for a few hours, became a black, putrescent liquid, and when disturbed evolved the disagreeable odor of sulphuretted hydrogen. A very noticeable feature was the decided red covering on the surface of the percolating filters during rest, which assumed a greyish black color when in operation, which showed that a large quantity of the iron had been carried forward in the tank effluent, as chemical analysis confirmed.

During the period of Experiment 2, the physical conditions were somewhat similar to those stated above for Experiment 1, except that the dark color of the tank effluent gradually disappeared on standing.

There was a marked difference in the physical conditions when Experiment 3 was in progress. The improvement was so marked that the superiority of [illegible] as a precipitant really needed no analysis to show it. The [illegible] on the works was reduced to a minimum [illegible] if any tank effluent was left stagnant [illegible] in smell.

The filters at the works [illegible] quantities of [illegible] which were [illegible] during the time ferric sulphate was being used [illegible] condition.

As the best conditions of [illegible] further experiments were [illegible] at a later period with the use of lime alone, [illegible] amount which [illegible] the cost per million gallons [illegible] those already undertaken [illegible] found to be 7.6 grains per gallon on the D.W.F.

At this time the strength of the sewage [illegible] owing to a certain trade waste [illegible] constituted one-tenth of the flow [illegible] that of the normal [illegible] in solution and [illegible] by the chemicals added. Consequently in carrying out these further experiments one of the tests already described had to be again undertaken so that errors in comparison could be reduced to a minimum.

The experiments undertaken were:

(1) The addition of 1.9 grains per gallon of aluminium sulphate plus 2.8 grains per gallon lime, calculated on the dry weather flow.

(2) The addition of 7.6 grains per gallon of lime, calculated on the dry weather flow.

The tests were carried out for a similar period to those already described, with exactly the same conditions, etc.

The results of the experiments just described settled the question of which was the best precipitant for the sewage under examination. By considering the percentage purification obtained by tank treatment as measured by the following tests:—

1. Four hours' oxygen absorption test;
2. Albuminoid ammonia test;
3. Colloidal matter test;
4. Suspended solids,

tabulated below, the aluminium sulphate and lime as formerly used easily takes the premier place.

FIRST EXPERIMENTS.

	4 hours oxygen absorption test	Albuminoid ammonia test	Colloidal matter test	Suspended solids
Ferric sulphate alone	[illegible]	[illegible]	[illegible]	[illegible]
Ferric and lime	[illegible]	[illegible]	[illegible]	[illegible]
Aluminium sulphate and lime	[illegible]	[illegible]	[illegible]	[illegible]

SECOND EXPERIMENTS.

	4 hours oxygen absorption test	Albuminoid ammonia test	Colloidal matter test	Suspended solids
Lime alone	[illegible]	[illegible]	[illegible]	[illegible]
Aluminium sulphate and lime	[illegible]	[illegible]	27.7	71.6

The results obtained by the aluminium sulphate and lime in the second experiment do not show such marked differences as those in the first. This is accounted for by the trade waste mentioned, which developed acid fermentation before reaching the works, the sewage invariably showing an acid reaction, and the fermentation proceeded when passing through the tanks. Hence the increased amount of suspended solids, with correspondingly poor results in the other tests.

The colloidal matter test is described by Fowler, Evans, and Oddie, in a communication to the Society of Chemical Industry, March, 1908, and is an excellent test when carrying out experiments on the preliminary treatment of sewage.

Comparison of Results With Those Obtained by Other Laboratory Experiments.—The results obtained from the experiments just described—viz., (1) aluminium sulphate and lime, (2) ferric sulphate—are entirely opposite to the findings of similar experiments carried out in the laboratory

TABLE 1—RESULTS EXPRESSED IN PARTS PER 100,000.

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Tank effluent			Filter effluent		
Ammoniacal nitrogen	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	4.23	.063	....	....	....	....	....	....
Albuminoid nitrogen	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nitrous nitrogen			[illegible]			[illegible]			Trace	....	[illegible]				
Nitric nitrogen									[illegible]						
4 hours' oxygen absorption test	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Due to suspended solids	[illegible]				[illegible]		[illegible]	[illegible]							
Due to colloids				[illegible]	[illegible]		[illegible]	[illegible]		16.0	[illegible]	[illegible]			
Due to crystalloids	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]							
Suspended solids	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chlorides (in terms of Cl)	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30.9	....	....	....	....	....	....

The experiments were carried out in tall glass cylinders, the amount of chemicals being added in a liquid form. The samples were well mixed, and allowed to stand four hours, at the end of which time the supernatant liquid was syphoned off. The following shows the analysis of such decanted liquids, which are concordant with those undertaken by analysts prior to the above investigations:—

	Settled for four hours with		
	Crude sewage.	Lime and alum. sul.	Ferric sulphate
Four hours oxygen absorption test..	6.51	3.20	3.06
Per cent purification	...	50.8	53.0
Albuminoid nitrogen	.75	.39	.32
Per cent purification		48.0	57.3
Suspended solids	21.5	2.1	2.0
Per cent purification		90.2	90.7

By comparison of the percentage purification obtained, it would appear that ferric sulphate is superior, though the difference is not so marked as in the practical-scale experiments in which the aluminium sulphate proved to be superior. It is of the utmost importance to note that here we have a case of working-scale experiments refuting and reversing results obtained by small-scale laboratory experiments. The results obtained are tabulated together below:—

Precipitants used.	Lime and aluminium sulph.		Ferric sulphate.	
Scale of expt.	Laboratory.	Working.	Laboratory.	Working
Four hours oxy. absn. .	50.8	57.2	53.0	42.6
Albuminoid N.	48.0	48.1	57.3	26.0
Suspended solids	90.2	91.2	90.7	80.6

It will be noticed that in the case of lime and aluminium sulphate the working scale experiments show a slight improvement over those conducted in the laboratory, but in the case of ferric sulphate the reverse occurs in a marked manner.

It is obvious that large-scale experiments are never strictly comparable to laboratory experiments, owing to the impossibility of exactly reproducing all the conditions of the experiment; but, after all, these are subsidiary to the main conditions, and one would expect to get results which are comparative and not absolutely divergent. In this case, therefore, one must seek for a condition existing in the working-scale experiments which apparently affects one precipitant adversely and has no effect on the others.

The tanks used in the experiments were four in number and worked in series. The sewage, on coming out of Tank No. 1, passed down a narrow channel the length of the tank and thence into No. 2, and similarly into Nos. 3 and 4. In this way the sewage was agitated alternately with periods of comparative rest, and, as this does not occur in any of the laboratory experiments, it suggested to the author that the agitation in the carriers might possibly have the effect of again emulsifying some of the finely-divided solids. In consequence, a laboratory experiment was arranged to imitate these conditions. The sewage and precipitant, after being mixed, were allowed to stand for one hour, the supernatant liquid was syphoned off, shaken, and allowed to stand for a further period of one hour. The process was repeated twice more, and the final effluent examined, the results being tabulated below:—

Precipitant	Lime and aluminium sulph.		Ferric sulphate.	
Treatment received	After standing for four hours.	After treatment described above.	After standing for four hours.	After treatment described above.
Four hours oxy. absn	3.06	3.29	3.02	3.26
Albuminoid nitrogen	.31	.375	.32	.355
Suspended solids	2.4	2.8	2.2	3.0

The results show that, while the shaking has to some extent a deterrent effect, this effect is mutual to both precipitants, and therefore it would not appear to be the cause of the divergence noticed in the large-scale experiments.

It was found, on further watching the progress of the sewage through the tanks, that on its entry into the first tank it was met with a deep baffle board, which extended from 6 in. above the surface of the liquid to within 18 in. of the bottom of the tank. It then passed down the narrow channel already referred to into the succeeding tanks, where it met with a similar obstruction. As the tanks were worked in series, the accumulation of sludge in the first two was far greater than that in the latter two, and consequently the sewage, in forcing its way under the baffle boards, especially into No. 1 tank, would greatly disturb the deposit, some of which would become mixed with the fresh sewage. Again, the fluctuation of the flow will have a similar effect, especially when the flow is at its greatest, in all the tanks. It is therefore quite reasonable to assume that the sewage is considerably brought into intimate contact with the already settled sludge, and a laboratory experiment was undertaken to ascertain what effect this contact had on the settlement.

In the first place, sludge was accumulated by precipitating similar sewage with the two classes of chemicals under discussion. The experiment was then proceeded with as follows:—The sample of sewage was placed in glass cylinders as before, along with the solution of the chemicals, and with a further small addition of precipitated sludge. The sludge added to the cylinder containing the ferric sulphate precipitation was itself previously precipitated with the same chemical, which was also the case with the aluminium sulphate and lime. After gently mixing the contents, the cylinders were placed on one side to stand for four hours, when the supernatant liquid was syphoned off, and analyzed with the following results:

	Four hours' oxygen absorption test.	Albuminoid ammonia test.	Suspended solids.
ALUMINIUM SULPHATE AND LIME PRECIPITATION.			
After four hours' settlement....	3.56	.35	2.0
With 2 p.c. addition of sludge (96 p.c. moisture) and allowed to stand four hours	3.62	.35	2.6
FERRIC SULPHATE PRECIPITATION.			
After four hours' settlement ...	3.51	.32	2.0
With 2 p.c. addition of sludge (96 p.c. moisture) and allowed to stand four hours ...	3.96	.425	3.8
AN EXAMPLE WITH THE MACCLESFIELD SEWAGE.			
Precipitated with alum. sul. and lime, plus 2 p.c. addition of sludge and allowed to stand four hours	4.56	.745	3.8
Precipitated with ferric sul. plus 2 p.c. addition of sludge and allowed to stand four hours..	6.12	.96	7.4

The experiment, therefore, tends to solve the problem by demonstrating that the disturbance of the sludge has an inhibitory effect upon the settlement results when using ferric sulphate as the precipitant, but up to a certain point has little effect upon the aluminium sulphate and lime precipitation. A fact not previously mentioned when describing the practical experiments was the character of the resulting sludge from each experiment. The sludge from the ferric sulphate precipitation was a dense black colloidal substance, and is was impossible to dehydrate same in filter presses with an addition of 1½ per cent of caustic lime, and a pressure of 100 lb. to the sq. in. The sludge resulting from the aluminium sulphate and lime precipitation was greyish in color and produced a stiff cake when pressed.

If one considers the experiment just described in conjunction with the physical conditions existing during the time ferric sulphate was added when carrying out the practical experiments—viz., the color of the tank effluent with its distinct color of sulphuretted hydrogen, the greyish-black covering of the filters when working, which assumed a

RESULTS EXPRESSED IN PARTS PER 100,000.

	Adding 7.6 grains per gal. of lime.			Adding 1.90 grs. of sulphate of alumina, 2.8 grs. of lime per gal.			Percentage of purification (calculated on crude sewage). Tank eff.		Filter eff.	
	Crude sewage.	Tank effluent.	Filter effluent.	Crude sewage.	Tank effluent.	Filter effluent.	Lime alone.	Sul. of alum plus lime.	Lime alone.	Sul. of alum plus lime.
Ammoniacal nitrogen	2.18	2.25	.17	2.96	2.88	.105	....	....	....	....
Albuminoid nitrogen	.57	.38	.12	.71	.405	.105	33.3	43.0	78.9	85.2
Nitrous nitrogen ..	.	...	.03	....	....	.055	....	....	....	....
Nitric nitrogen	...	. .	1.79	...	....	2.11	....	....	....	....
4 hrs. oxygen absorption test	8.43	5.16	.91	8.86	4.15	.97	35.2	49.8	89.2	89.0
Due to suspended solids	2.16	.	...	2.54	....	....	....	....	....	....
Due to colloid	1.96	1.50	....	2.29	1.59	....	25.5	27.7	....	....
Due to crystalloid	1.01	...	....	14.12	....	....	....	....	....	....
Suspended solids	18.9	5.5	5.9	22.1	1.8	4.1	70.1	78.6	68.8	81.7
Chlorides (in terms of Cl)	20.6	21.2	19.5	20.7	17.9	18.1	....	....	....	....

rusty color when resting, and the condition of the resulting sludge just referred to one can safely conclude that the principal trouble and failure of the ferric sulphate was mainly due to the resulting tank effluent and sludge containing an excessive quantity of iron sulphide.

Immediately the ferric sulphate is added to the incoming sewage it is converted into ferric hydrate by the alkalinity of the sewage, and is thus in a most available form for reacting with sulphuretted hydrogen, and being intimately mixed with the sludge when settled is ever available for reacting with the sulphides and sulphuretted hydrogen produced from the decomposition of the sludge, forming iron sulphide.

As already stated, the incoming sewage is forced by means of the baffle boards to a depth in the tanks where it greatly disturbs the already settled sludge, and will carry into suspension or pseudo solution any iron sulphide the sludge may contain owing to it existing in a very fine state of division. Except for the oxygen absorbed test, iron sulphide will have little effect upon the chemical analysis and consequently the poor results shown, especially by the albuminoid ammonia test and suspended solids, is probably due to finely divided organic solids being carried into suspension and pseudo solution by the iron sulphide.

An experiment was undertaken to ascertain the inhibitory effect of iron sulphide to efficient settlement. Measured quantities of sewage were placed in two glass cylinders and 4 grains per gallon of ferric sulphate added to each, plus 2 per cent of (96 per cent moisture) ordinary settled sludge taken from the works. They were both shaken, and into one was placed a small quantity of iron sulphide in pseudo solution. The two cylinders were allowed to stand the usual four hours and then siphoned off, with the following results:

	Albuminoid nitrogen	
Cylinder containing	Weak sewage	Strong sewage
(1) Ferric sulphate plus 2 p.c. sludge	41	[illegible]
(2) Ferric sulphate plus 2 p.c. sludge and F. S.	18	[illegible]

To demonstrate the buoyancy of iron sulphide, a column of water, 12 in. in depth, containing iron sulphide, settled less than $^1/_4$ in. in 24 hours.

In the absence of available iron the sulphides in the sewage and arising from decomposition are probably fixed by the lime salts already contained in the sewage. In many instances lime is added to the sewage as an aid to precipitation, and it is probably due to its absorbing or reacting with the sulphuretted hydrogen that it is in such great repute as a sewage precipitant rather than its actual precipitating value.

It might be of interest to mention that for some years a cheaper product of aluminium sulphate has been available, and since 1911 this chemical—containing iron—has been universally used where precipitation is in vogue, owing to the aluminium sulphate formerly used not being obtainable for sewage precipitation. As the following analysis shows, the mixed oxides in the cheaper chemical are higher than those contained in the better quality aluminium sulphate, and consequently as precipitants are usually valued on their cost per unit, the new product was considered far better value of the two:

	Ferric oxide	Alumina	Total oxides
Aluminium sulphate used prior to 1911	.85	11.03	11.88
The cheaper product of aluminium sulphate	5.10	10.46	15.56

The author found, however, that the results obtained with the cheaper product were much inferior and this was also the experience of several other sewage works managers and chemists with whom the matter was discussed. It was soon observed that the tank effluent was not so bright as formerly, liable to cause aerial nuisance, and also that the resulting sludge was very difficult to dehydrate. It will probably be found on most of these works that baffle boards are in use, being fixed in the majority of tanks for the express purpose of preventing short circuits of the incoming sewage and so contriving to give the whole of the sewage its full period of settlement.

At one time the author acted as chief assistant to the manager and chemist of the Bolton Corporation sewage works, where chemical precipitation was in vogue. The precipitants were manufactured on the works, and it was found when using equal weights of a precipitant containing only 12 per cent of mixed oxides, mostly alumina, as good, if not better, results were obtained than [illegible] one containing 18 per cent of mixed oxides (12 per cent being ferric oxide and 6 per cent alumina) notwithstanding that when considering units, the latter precipitant represented 50 per cent greater precipitating value than the former.

Conclusions and Discussions From the Experiments and Results. (1) That while laboratory experiments give useful information as to the value of various chemicals on a particular sewage, they do not necessarily represent working scale results.

(2) That in considering chemical precipitation, the design of the settling tanks is quite as important a factor as the nature and class of sewage to be treated.

(3) That sludge disturbance is inhibitory to efficient settlement, and fatal when iron salts are used as the precipitant.

(4) That even small quantities of iron added with the aluminium sulphate have in conjunction with sludge disturbance an adverse effect upon settlement.

In tanks which give the minimum disturbance of sludge, such as the "Travis" tank, splendid results are stated to be obtained. The following results obtained with such a tank at Norwich, were submitted by Mr. Roechling, M. Inst. C. E., to the discussion on the former part of this paper before the Society of Engineers:

	Percentage purification	
Suspended solids	[illegible]	[illegible]
Organic matter	[illegible]	[illegible]
Albuminoid nitrogen	[illegible]	[illegible]
Oxygen absorbed	[illegible]	[illegible]

It is quite reasonable to assume that similar results would be obtained by the Imhoff tank, where owing to the sludge being deposited in a separate compartment, its disturbance is negligible. The high cost of those two tanks invariably makes their adoption prohibitive, and the majority of tanks constructed in the past have been those of the rectangular type. With this design it is necessary to devise some means of preventing short circuits, and this has usually been accomplished by fixing one or more baffle boards across the tanks. As previously stated, this is liable to cause the already settled sludge to come into intimate contact with the incoming sewage, unless the tanks are constantly cleaned out with a regularity seldom possible on a sewage works.

An alternative method of baffling the sewage which would not have such a grave disadvantage is therefore desirable.

As the result of careful investigations on the design of settlement tanks in general, Mr. Clifford, A. R. C. SC., of Wolverhampton, recommends an inlet arrangement whereby the energy of the incoming flow is dissipated by the production of eddies within a special guard chamber.

Dr. Ardern, consulting chemist to the Manchester Corporation Rivers Department, has had such inlets placed in the settling tanks in connection with the activated sludge plant, and, notwithstanding the extremely flocculent nature of the suspended solids, they are stated to give excellent results.

(5) That the formation of iron sulphide in settling tanks is liable to cause many difficulties in the efficient purification and disposal of sewage.

As shown by the experiments, it carries finely divided organic bodies into suspension, gives cause for aerial nuisance, and is the principal cause of the difficulty in dehydrating the resulting sludge.

It is further probably poisonous to the mass of life in bacterial filters, as evidenced by the filters voiding leeches either dead or in a dazed condition when using ferric sulphate as the precipitant.

Dunbar, in his admirable book on sewage treatment, lays strong emphasis on the neglect paid to the sulphur content of sewage, and states that iron sulphide is more difficult to oxidize on the filtration area than organic sulphur.

Rubber Pavement.—Although there are places in London and elsewhere where rubber has been used as a road surfacing material over small areas, it has hitherto only been adopted for the purpose of deadening the sound of traffic in situations where quiet is essential. A large scale experiment with rubber pavement is now being made by the Southwark (England) Borough Council, according to The Surveyor. Half only of the road is being surfaced with rubber, so as to afford a comparison in efficiency. The new material is being laid in flat slabs $^3/_4$ of an inch in thickness, attached to steel plates, from which project broadly flanged studs, which are gripped by the concrete foundation.

Electrons and the Engineer

Editorial in The Engineer, London [illegible]

At first sight it would not perhaps appear that even an important advance in our knowledge of the internal structure of the atom should excite anything but a purely academic interest in the minds of engineers and of practical men generally. This is one of those branches of "pure" science which the ordinary individual regards as entirely "beyond" him; he may echo the opinion which has of late found vigorous expression in some quarters that such research is "important," but he is content to leave it to a small band of enthusiastic workers whom he is inclined to regard with something between indifference and the semi-contemptuous tolerance which he accords to people who are not "practical." Yet no one gifted with even a small share of insight could have listened to Sir Ernest Rutherford's "Bakerian Lecture" at the Royal Society without realizing that here was something which not only fundamentally affects all our scientific conceptions, but also something which, sooner or later—and probably sooner rather than later—is bound to affect our practical lives and perhaps to alter the whole aspect of human life and activities.

It is true that the epoch-making events which have just been chronicled have occurred only within the narrow walls of a vacuum tube, and that the effects have been confined to a few atoms whose behavior has been counted one by one. It is much too soon to say why and how these things are likely to affect the practical world as the engineer knows it; yet we have often seen how the most abstruse scientific discovery brings vast results in its train, and it will be more than surprising if a similar sequence of events does not follow in the present instance. In the past such a development has been slow, because only few scientific workers and technical workers were in the field. Today there are, by comparison, huge numbers of such workers, and progress and development are likely to be rapid. Any surmise as to the possible direction which such development may take can, at the present stage, be nothing more than, at best, intelligent speculation. A survey of the possibilities involved may, none the less, be useful as well as interesting.

To the chemist and the physicist the outstanding feature of Sir Ernest Rutherford's recent work will lie, no doubt, in the fact that he has demonstrated that the transformation of one of the so-called chemical elements into another, with which we have hitherto been acquainted only in the case of the few and entirely exceptional bodies which possess the mysterious properties of radio-activity, can be caused to occur in such ordinary substances as nitrogen and oxygen. When, under suitable conditions, atoms of nitrogen are bombarded by the alpha-particles shot out from radium or its emanations, Rutherford has shown that atoms of hydrogen make their appearance, while a new kind of atom, not hitherto met with in quantity, has been formed by the similar bombardment of oxygen atoms.

So far this startling series of transformations has only been carried out on an ultra microscopic scale, and by the aid of the most powerful of all available agencies—the alpha-rays of radium. But Rutherford's discourse made it quite clear that in his opinion the disintegration of the lighter kinds of atoms at all events might be possible by other more widely available means. The fundamental fact that the atoms of substances not in themselves radio-active can be disintegrated by artificial means has been established very fully and definitely. The carrying out of such an operation on any large scale is, of course, quite another matter; but new fundamental facts extracted from the secrets of nature are potent things with which it is very necessary to reckon.

Let us then, examine one or two of the possible bearings of this new knowledge on the work of the engineer, whose business it is to utilize the forces of Nature for the benefit of man. We have, first of all, the demonstration that the conception of the atom as a nucleus carrying a positive electric charge, surrounded by and intimately connected with a group of very minute "electrons," is substantially correct, for it has pointed the way to the discovery of how to disintegrate old atoms and to build up new ones. But this conception also serves to show how the atoms, particularly when built up into a crystal, are linked together—a linking which we ordinarily dismiss with the vague term of "cohesion."

There seems little doubt that the active agent in "cohesion" is the intensely minute electron, a particle which bears to the atom as a whole something of the same order of relation which the planets bear to the solar system. Atoms, when built together, either into chemical compounds or into crystals, are linked together by their electrons. They may have one or more electrons in common, or the electrons belonging to one atom may fit into vacancies existing in the electron system of a neighboring atom. Now there is no property of matter which is of more fundamental importance to the engineer than this property of "cohesion"—the hardness of the diamond, the strength of tempered steel, or the softness and ductility of copper alike depend upon this property of matter. Given a deeper and truer insight into the inner mechanism of cohesion, such as this new research appears to offer, and we at once widen the possibilities of the materials available to us.

With regard to metals, for instance, modern metallurgy has given us immensely improved steels and alloys, but only the most proximate explanations of why one particular form of matter is so much superior to others. Given the key to the true inwardness of cohesive forces, it is not too much to say that we might well look forward to an era of engineering materials which should surpass the achievements of the present era of "alloy steels" as much as the iron age surpassed the bronze age. We are not yet upon the road to that era, but the first finger-post leading to that road has just been shown to us.

From another point of view these recent advances in our knowledge of atomic structure and transformation are, if possible, of still greater interest. The enormous store of energy which lies within the structure of the atoms themselves has come to our notice from observations on radium and on the heat which it steadily generates as a result of its spontaneous disintegration. The lively imagination of Mr. H. G. Wells has familiarized us with the idea that some day it may be possible to utilize this internal energy of the atom for destructive purposes by releasing it at will, and he has painted us a lurid picture of the destruction wrought by such "atomic bombs."

More peaceful speculation has suggested that in this great store of energy we shall ultimately find an inexhaustible source of power, not only solving the problem of the exhaustion of coal and oil, but for ever relieving the human race from the burden of physical toil. Those were mere speculation until it could be shown that the stores of atomic energy could be released by human manipulation; but now Sir Ernest Rutherford has shown that at least, ordinary atoms can be caused to undergo disintegration by external agencies, and we are one tremendous step nearer the realization, not perhaps of those particular dreams, but of a new world in which we shall possess a degree of control over matter and energy so much greater than that which we possess today that it is difficult to foresee the consequences.

In his delicate experiments, Rutherford does not speak of having met with any manifestations of the release of large amounts of energy as the result of atomic disruption, but his experiments were not directed to that end. Even if, in the particular cases which he has studied, there is no great gain of energy, it does not by any means follow that such a result may not occur when the path he has opened up is further explored. It may be, indeed, that we shall not find the atomic energy making itself manifest in violent explosions or incandescence, but in quite a different way. In the more speculative part of his lecture Rutherford suggested—in a perfectly calm and breezy manner—the probability that atoms of either oxygen or nitrogen might be broken up in such a way as to lead to the formation of atoms of carbon. Should such an amazing transformation ever become realizable on a large scale a supply of power of unlimited extent would at once become available. We can, of course, effect a somewhat similar change—of a much more conventional nature however—by the decomposition of carbon dioxide into carbon and oxygen, but there the obstacle lies in the fact that the power or energy required to effect the separation is greater than that which could be again obtained by burning the resulting carbon. It is, of course, possible that in the atomic disintegration also energy will be absorbed, and that therefore, from the point of view of obtaining power, the process may not "pay." On the other hand, the carbon atom is lighter than that of nitrogen or oxygen, and in the case of radio-active bodies at all events we know that the breaking up of a heavier atom into lighter ones is accompanied by a release of energy and not by absorption.

We may therefore well hope that when Sir Ernest Rutherford, or other enthusiasts following in the path which he has pointed out, at last furnish us with the key to the inner mysteries of atomic disintegration, we shall be furnished with the means not only of producing at will any desired kind of matter but also—directly or indirectly—with a vast supply of energy or power for moulding it to our needs. These are of course for the moment nothing more than dreams of future possibilities, but the definite facts which Rutherford put before the Royal Society tend to make them seem much less hazy and distant, and those dreams much less unreal than they might have appeared even two years ago.

Causes of Corrugations or Waves in Asphalt Macadam

A correspondent in the July 22 issue of Municipal Engineering summarizes the causes of waving in asphalt macadam as follows:

"(1) Improper laying of the material with workmen of insufficient experience, for the material should be laid at a given temperature. If it is allowed to fall below a minimum temperature, the material will come out in a lumpy state from the vans delivering it on the road. (2) The iron rakes for leveling out the material are not made sufficiently hot to penetrate into the asphalt, the consequence being that the raking out of the lumps is not effected. They are scratched over only, and corrugations result. (3) Improper types of rollers used for rolling asphalt macadams are, in my opinion, another cause of corrugations. That this is so I have proved when laying asphalt macadam into two adjacent roads with two different types of rollers, viz., one of the English type where the engine is built above the level of the wheel axles, while the other was of the American type of roller, with the engine below the level of the axles, and so low indeed that it is only about 8 in. clear of the ground. Much superior results were obtained with the latter roller, although the conditions as regards the composition and the heating of the material, etc., were similar. The presence of corrugations in the former and their absence in the latter were very perceptible. (4) Another cause of troubles arises from excessive thickness of the material, producing unequal compression. The standard thickness of $3\frac{1}{2}$ in. in two-coat work should not be exceeded. (5) The improper bonding of the upper and lower coats is another cause leading to the formation of corrugations. If the lower or under coat is of too coarse material, then the upper or carpet coat material is driven into it. The proper gauging of the materials of the two coats is most important, and especially, too, is the combination of the gauges of sands in the upper or carpet coat."

Letter in the Aug. 12 issue of The Municipal Engineering:

The various suggestions made in the letter in your July 22 issue with regard to the cause of corrugations are undoubtedly correct.

In the writer's experience, however, one of the most important factors in wave-reduction is a careful consideration of the aggregate.

It should first be recognized that whether the aggregate is a granite, or the generally-used sand, the particles are impervious, and they merely become coated with bitumen, which fills the intervening spaces, no matter how minute.

Now, sands may be divided into three classes: angular, sub-angular, and round, and it would follow that if the sand used is round, the particles have an increased tendency to roll, and are quickly affected by the run of the wheels.

The sands differ considerably. In some instances there is angularity with no rounding, in others mainly sub-angularity; and in not a few the particles range from sub-angular to round.

From continuous observation of different classes of work both during construction and subsequent behavior under traffic, the writer has concluded that in many cases the principal reason for the difference between one class of work which is found to be of general excellence, and that of another class which waves, although the conduct of the work has been practically equal in skill and attention, is due to the differing character of the aggregate.

Material of a porous nature and angular and possessing a roughened surface gives, with a matrix, a high power of resistance to the wheel, due regard with the use of such material being had to careful grading to the obtaining of a close and stable texture.

The Professional Man and Industrial Unrest

By [illegible]

[illegible]

One of the greatest problems [illegible] the world today is that of industrial unrest, and [illegible] almost all other difficulties and problems there is this [illegible] question. How can the whole of these [illegible] whatever their [illegible] be brought into closer touch [illegible] harmonious relationship? I [illegible] the professional man is called upon to [illegible] in the solution of this at present [illegible] problem. We are by reason of the nature of our work brought into close contact with the people [illegible] and lives than almost any other section of the educated classes. Moreover experience has taught some of us that the operatives would welcome the advice, encouragement and co-operation we might give.

In order that we may be of real service in this matter it is essential that we should seek to enter to a far greater extent than hitherto into the councils of the building and engineering [illegible]. I am aware there are many objections that may be raised to what might be termed our interference, at the same time there are a far greater number of reasons to be advanced in support of some action on our part. That there will be difficulties goes without saying. These will be chiefly met by the man in private practice, but after all is said, the architect and the engineer are the chief workmen. True, theirs is the creation, theirs the inception, but theirs also is the finished work, and the "drawers of water and hewers of stone" are fellow craftsmen, and in these days of direct labor and semi-direct labor the architect or engineer has far greater opportunities of getting into touch with the men whose business it is to shape and fashion that which has been designed than had their predecessors. Time will not permit me to dwell upon the subject of saving in cost that might be effected. It is a vital one, however, and men who are contented are far better workers than men who are not. Contentment means good work and increased production, and increased production means, as we are so often told, more work to be done, and therefore greater contentment.

It is certainly a little difficult to indicate clearly how the professional man in private practice may best assist in bringing about this most desirable state of affairs. Of one thing I am quite sure, and it is that whoever the operative may harbor a real or fancied grievance against, he certainly has no ill-will toward the architect or engineer, although he does feel that he himself is too often treated as though he were just a machine. By this I do not infer that he is hard driven or unkindly controlled—the day of such things has certainly passed—but the average mechanic, who is educationally far in advance of the mechanic of a generation ago, does feel that he is called upon to carry out some small portion of the work without any enlightenment as to the greater whole to which he is contributing. His peculiar work may be and often is uninteresting, yet if he be allowed an insight into the scheme of things in their entirety, he would at once have a different outlook, an enlarged vision. Is there anyone better fitted, more able to call into being this spirit of comradeship, this atmosphere of the "Guild," than the chief workman himself?

If I may, I will turn for a moment to consider the possibilities of this as it affects the official architect, engineer, or surveyor, and more particularly the man who deals with direct labor. During the five years of war it was my duty and privilege to be responsible for the work and well-being while at work of some 5,000 men engaged upon building and engineering work, and while so engaged I, in common with most men, changed my views upon many subjects, and, among other things I discovered was that the average British workman is a far more reasonable being in every way than is usually supposed. I do not hesitate to say that much of the unrest is due to the fact that often those in authority do not clearly and sympathetically understand the "other man's" point of view. The more or less personal affairs of the men are nearly always dealt with by men in subordinate positions and by those whose outlook is somewhat limited, whereas surely we who are dependent upon the men for the carrying out of the schemes entrusted to us, should take a very real interest in their welfare. For the most part we have no conception of the conditions under which the workman lives and carries out his daily work. The fear of unemployment has for many years dogged his footsteps, the distance he often has to travel to and from his work; domestic problems that to him assume far greater proportions than, maybe, to ourselves—all these things affect him. Misunderstandings arise between foremen and workmen when each, maybe, is inclined to stand upon his dignity, and troubles follow quickly one upon the other. In this connection the introduction of a wider knowledge, a greater breadth of thought, will often dispel much of the trouble. It is here that the professional man has a great opportunity. I venture to put it even more strongly. I believe that in this matter there is today a distinct call to each and all of us to bring all our knowledge, experience, and influence to bear upon this great problem—the unrest of today.

During the war thousands of men like ourselves were called upon to deal with many strange problems, and often we were a little surprised at the success which attended our efforts in some such direction as I have endeavored to indicate. Is there any reason why we should throw away the fruits of our experience? Personally, while I have found that some of the men are unreasonable and hard to deal with, I have also found a far greater number who are open to reason and who are anxious to do all in their power to assist at all times in bringing about such a state of affairs as shall be conducive to the uplifting and well-being of every class, and, even at the risk of too much reiteration, I say that you and I have a special call to the task of uniting all good men and true in the truly noble work of building anew the fabric of a great industry. Tolstoy said: "Labor is the joyful business of life." Alas! it is not always so, but it should be. All men should be encouraged to take pleasure in their work, and it should be our great aim to see that they have pleasure therein.

It is an easy thing to engender discontent and unrest. It is difficult at times to cultivate the restful spirit, to bring about the happy co-operation so necessary if we are to successfully grapple with the problems that lie before us; but in the doing of this we shall be conferring upon ourselves and upon posterity lasting good.

Light Concrete Hangars with Curved Roofs

From Le Constructeur du Ciment Armé, Paris.

Reinforced concrete has the following advantages for hangars: They are fire-resisting; the cost of repairs is reduced to a minimum; they are extremely rigid, due to their monolithic structure.

On the other hand, there are certain disadvantages due mainly on account of the necessity of forms. These disadvantages he states to be as follows: They necessitate the use of forms during construction; they cannot be dismantled or altered

In the case of light hangars these difficulties are increased by: the forms are costly and complicated; the cost of the forms is the same as for a hangar of heavier construction; the construction is generally more massive than would be necessary if wood or galvanized iron is used.

Hangars with curved roofs have the following advantage: The amount of material used is reduced to a minimum; It is possible to obtain a sufficiently satisfactory impermeability with a simple coating of rich cement; the shuttering is simplified by placing the ties above the roof; the curved pieces of shuttering may be used repeatedly; the dismantling of the curved portions of the roof may be effected much more rapidly (in about a fortnight) without danger

The following precautions are essential: The height of the eaves must not exceed 16 ft.; the longitude distance between the pillars must not exceed 16 ft. and the span must not exceed 10 ft., thus giving a maximum free space of 15 × 10 = 640 sq. ft.

The following suggestions apply to a simple hangar, open on all four sides. The loads carried by the hangar include:

(1) Its own weight, calculated on a density of 2,400 kg., corresponds to a load of 300 kg. per square inch, or 7,333 lb. per square foot.

(2) A fall of snow equivalent to 1,464 lb. per square foot of covered surface or a surcharge of 732 lb. per square foot of snow added to the effect of a wind with a pressure of 3,660 lb. per square foot of normal surface.

(3- In calculating the sizes of the pillars it has been assumed that all the four walls were in position and had to resist a wind-pressure of 3,660 lb. per square foot at the top, decreasing gradually to nil at the base of the wall.

The concrete contains 560 lb. of Portland cement per cubic yard and has a safe compressive strength of 714 lb. per square inch.

The essential details of the structure include:

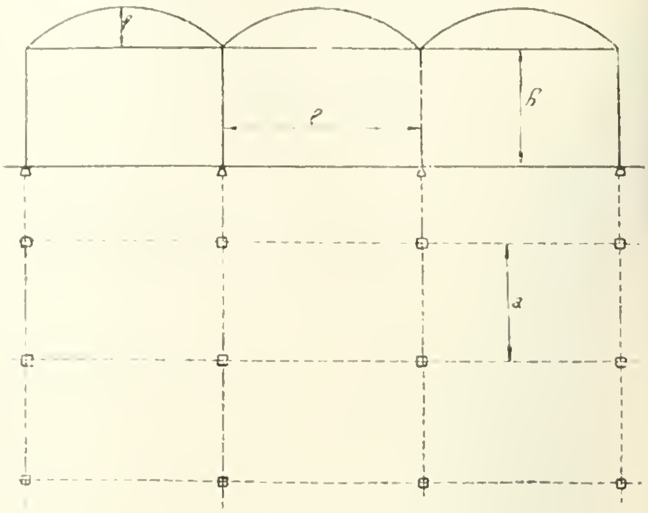


Fig. 1—Elevation and Plan.

A rib 25/18 shown in the roof gutter for carrying off water.

A tie composed of one piece of 16/18, and supported by hanging truss-posts of 6/18. These must be protected from damp and acid vapors by a good coat of paint. These ribs, which have a span of 10 m., are 1 m. apart. They rest on pillars 18x23 cm. Those resting by means of a slab 0.75x 0.75 m. on a thin slab of concrete 0.90x0.90 m. are sufficient even for a poor soil

Side and end walls are easily built of bricks crossed with wooden ties, or reinforced concrete constructed in situ without shuttering. If the foundation is really bad, an ashlar course of reinforced concrete may be built under the partitions and between the feet of the pillars.

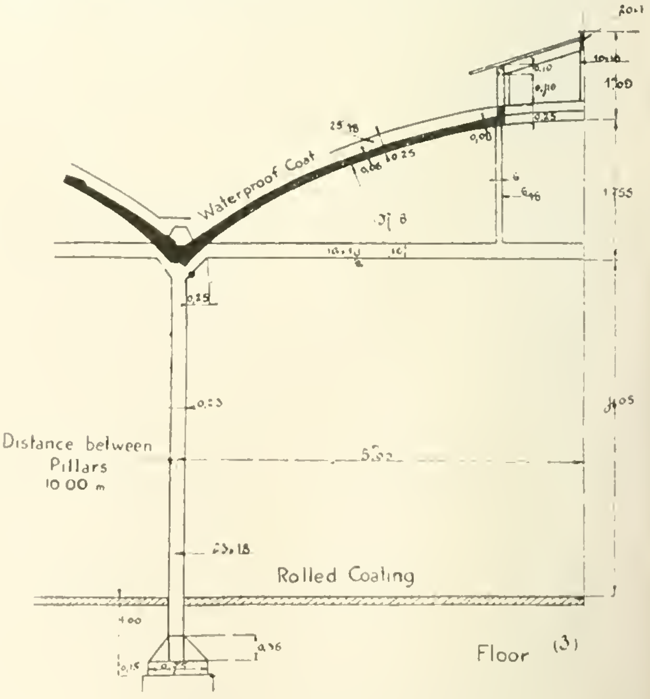


Fig. 2—Half Vertical Transverse Sections.
All dimensions are in metric system.

The portion of the roof between the rafters is composed of a slab of reinforced concrete about 2½ in. thick. The ties project from this in such a manner as to form a continuous intrados, and thus simplify the shuttering. Resistance to weather is assured by [illegible] cover of 990—1,100 lb., extending [illegible] the extrados. Outside openings in the end wall [illegible] and a lantern 7—10 ft. wide at the top of each [illegible] provide light and ventilation.

The ties cross at the base of the lantern. As they are 13—16 ft. apart one or two keys [illegible] square should be fixed between each rafter to connect the [illegible] of the lantern. This arrangement gives [illegible] when only three spans are used at a time [illegible] when the whole structure is not more than 100—120 ft. [illegible]

Expansion joints should be provided every 100—140 ft. allowing a space of ¾ in. in the [illegible] of the rafter, this being made of two pieces each 10 in. by [illegible] in. The slit is extended to 7 ft. underneath the wall plate. The position of the slit relative to the top of a rafter adds greatly to the efficiency of the means commonly used to mask it.

The only part of the shuttering which has any special interest is that relating to the intrados of the roof. It is advisable to have ties arranged to prevent the wall plate projecting between the pillars. It is then possible to use the same curve-pieces (made originally for the chief span of 40 ft.) for the lower spans. It is sufficient to preserve the same outline of neutral fibre in the tie of the various ribs to pass out of the lantern and cross on 20, 40 or 60 in. the ends of the curve pieces of the two adjacent chambers. The bottom of the wall-plate is then closed by a simple plank.

The arrangement shown effects a great saving in materials, especially when a large number of structures are to be built in the same locality, but it is not applicable to those with spans of more than 40 ft., or with distances of more than 16 ft., without serious risk of accident. Where these dimensions are not exceeded, this method of construction is cheap, rapid, light and fire-resisting.

Light Weight Concrete

From The Times Engineering Supplement, London, June 1920.

In a communication to the Académie des Sciences Lieutenant-Colonel Rabut, consulting engineer of the French State Railways, discusses the advantages to be derived from the use of light-weight concrete. He points out that in masonry and mass concrete work dead-weight is nearly always a cause of deterioration and consequent expense, which has been combatted in the past by hollow construction where practicable, by employing cement in place of lime mortar, in more recent years by the introduction of iron or steel as reinforcement, and finally by the selection of light-weight stone or aggregate. It may be conceded at once that if the dead weight of concrete can be reduced without a counter-balancing reduction of strength and durability the usefulness and economy of reinforced concrete can be very widely increased. Colonel Rabut points to various important railway bridges he has constructed in reinforced concrete with slag as aggregate, and to other structures he has carried out with light concrete, where gravel was replaced by volcanic stone, and expresses the opinion that concrete can now be made weighing half as much as gravel concrete, yet possessing strength equal to that of the latter. This view is by no means universally accepted, but if it could be substantiated conclusively by experiments and practical tests, doubtless every reinforced concrete engineer would join in the rush to make use of light-weight concrete.

Trial of Rivetless Ship.—Successful trials have been carried out on the Mersey and the Clyde by the electrically welded motor ship "Fullagar," built by Cammell Laird & Co., Ltd., Birkenhead. The vessel is notable in that not a single rivet has been used in her construction, the hull being welded throughout. The "Fullagar," which is 150 ft. in length, is intended for the coasting trade, and is fitted with a "Cammellaird-Fullagar" oil engine of 500 b.h.p. The engine has four cylinders of 14 in. in diameter, each piston having a stroke of 20 in. and works on the Diesel cycle. On the voyage from the Mersey to the Clyde very rough weather was encountered, but the engine ran steadily throughout, no racing being experienced, and there was only a slight variation in the revolutions.—Engineering and Industrial Management, London, Aug. 19, 1920.

Comparative Costs of Steam and Electric Operation of Turbine Pumps.

By [illegible]

From Water and Water [illegible]

The following figures have been compiled to show the comparison in running costs of steam and electric pumps. The unit of quantity adopted throughout is 1,000 gal. per hour raised 100 ft. or 100,000 ft. gal.

The Exeter installation consists of two steam pumps, two water-power pumps and an electrically driven pump, the latter being used as an auxiliary to both the steam and water pumps. The electric pump is driven off 60 cycle three-phase current. In winter the waterpower is sufficient to cope with the demand excepting for short periods when the river is in flood. The electric pump is then run to assist the water-power. In summer the large steam pump is kept working and also the water plant unless the water fails, when the electric pump is used.

It is rather difficult to allocate the running costs to the several pumps, as one man stokes the boiler and looks after the steam plant when one pump only is at work, but two men are required when both steam pumps are running. In 1919, from Jan. 1 to Dec. 31, the large steam pump raised [illegible] gal. against a head of 160 ft. in 3,218 hours, and the small steam pump 20,88[illegible],000 gal. to a height of 240 ft., in 1,0[illegible] hours, using 580 tons of coal. The cost of attendance and fuel only, neglecting capital cost and repairs, was as follows:

	£
[illegible] hours at [illegible] for attendance	268
[illegible] tons of coal at [illegible] per ton	1,613
Total	1,881

Adding the above quantities of water together, the total raised was 538,700, 100,000 ft. gal., and the cost per 100,000 ft. gal. = 0.838d.

The costs of electric pumping were as follows:

	£
1,041 hours at 1s. 3d. (this being the time two men were required out of the 3,511 hours run)	65
[illegible]3,016 units at 1.12d. per unit	1,083
Total	1,148

The duty of the pump is 25,000 gal. per hour against 340 ft. lift, and running this for 3,511 hours equals 298,430 units of 100,000 ft. gal., the cost per 100,000 ft. gal. being 0.923d.

The City of Hereford has three electrically driven pumps, working off three-phase 50 cycle circuit, two sets delivering 60,000 gal. per hour, the other set delivering 20,000 gal. per hour, against a total lift of 120 ft. in each case. The costs, as recently taken out, show that with electricity at 0.75d. per unit the cost of electric pumping is 0.5d., as compared with 0.126d. per 100,000 gal., the cost of steam pumping. These figures include men's wages, lubricating oil, waste, etc.

The Newbury District Water Co., early in the year 1912, took careful tests of their compound, condensing steam pumps and of their electric pumps. The latter are driven by direct current motors, one set having a capacity of 30,000 gal. per hour against 185 ft. lift, one set 20,000 gal. per hour against 150 ft. lift, and a further set 3,000 gal. per hour against 161 ft.

The 1912 costs work out at 1.18d. per 100,000 ft. gal. for steam, as against 0.957d. for electrically driven pumps, but for 1920 the figures are 2.61d. and 1.576d., respectively.

The South Staffordshire Waterworks Co. have installed two booster pumps of the self-regulating type at Coneygre, near Tipton, one of which is sufficient for the demand, the other being a stand-by pump. The pressure on the suction side varies between the limits of 80 lb. and 120 lb. per square inch, and the pumps are each designed to boost this pressure by varying degrees up to 85 lb. in excess of the above, the horsepower for driving the pumps remaining constant. The duty of each pump is normally 22,500 gal. per hour, this being increased as the pressure is reduced up to 32,500 gal. per hour with 50 lb. added pressure. In common with this class of pump, no air vessels or relief valves are necessary on the discharge side, a non-return valve being arranged to safeguard the pump from any possible water hammering.

The Chester Waterworks Co. have installed a Diesel engine and dynamo supplying current to drive turbine pumps built by Sulzer and the Rees Roturbo Co. The costs of running are given below:

Fuel oil	0.311d.
Wages	0.244d.
Stores, lubrication, etc.	0.052d.
Repairs, spares, etc.	0.039d.
Insurance	0.011d.
Total per 1,000 gal. 100 ft. lift	0.657d.

The pumps are designed to pump 150,000 gal. per hour against 110 ft. total lift at 1,030 r.p.m. The Rees Roturbo pump is giving an efficiency of 80 per cent, and, in consideration of these excellent results, a further set is in course of construction. The figures given for combined efficiency include the dynamo, motor, and pump losses.

The Borough of Ipswich have installed at their Whitton station a Diesel engine, driven by a Citroen double-helical gear a vertical spindle Sulzer pump. This installation has been running now for six years, and has been entirely satisfactory in every way, in fact, the pump has never been raised for examination since it was installed. The efficiency is fully maintained, and the set runs without any trace of vibration. The pump delivers 1,500 gal. per minute against 187 ft. total lift. The Sulzer-Diesel engine is rated for 150 BHP., and gives ample margin to cover all contingencies. In the above pump no expenditure in connection with the pump or pump shaft has been incurred since it was installed. Being a vertical set, the spindle revolves in lignum vitæ bearings inside the rising main so that there is a certain amount of power lost in the friction of the pump shaft and couplings running in the water, whereas if this pump were coupled direct to the Diesel engine no doubt from 5 to 10 per cent of the power could be saved. The cost of pumping is as follows:

COST OF 1,000 GAL. PUMPED PER 100 FT. LIFT (1920).

Fuel oil (at £12 per ton)	0.380d.
Wages	0.270d.
Stores, lubrication, etc.; repairs, spares, etc.; insurance	0.082d.
Total	0.732d.

The Human Factor in Industry

From Engineering and Industrial Management, London, Aug. 5, 1920.

The prosperity of an industrial community is largely governed by the efficiency and energy of its wealth-producing classes. Of these the brain-worker is not the least important. To him we owe the comforts and refinements of modern society; he has been eager to wrest from nature the secrets she carried in her bosom and mould them to the use of man and the progress of humanity. He has devoted himself with enthusiasm and sacrifice to the patient and labored elucidation of scientific truths which have added much to the knowledge and resources of the world. He has made possible the marvelous productive capacity of a machine and labor-saving age. His place in industry, his training, scope, and encouragement would afford an interesting and profitable study. But the most perfect piece of mechanism is without value unless guided by labor. The most brilliant product of the mind cannot become material until labor has performed its function. The whole structure of industry is ultimately at the mercy of those who work with their hands. Their attitude towards the problems of production is of supreme importance, and inasmuch as that attitude at the moment gives rise to some anxiety, it is to this phase of the subject that attention is directed by Mr. Alexander Ramsay in a paper which he read before the summer meeting of the Institute of Mechanical Engineers.

The activities of the workers are divided into two main channels which are rapidly converging—the industrial and political. In the industrial sphere attempts are made to secure better conditions from the individual employer or group of employers, and in the political to obtain general advantage, and to effect ultimately a fundamental change in the organization of industry by the nationalization of the means of production and exchange. These ambitions are perfectly understandable and legitimate, and if the workers believe in them they are entirely justified in pursuing them; but there is an unfortunate disposition amongst a section of the leaders of the labor movement to regard the employer as one who stands between them and their reasonable aspirations, and who must accordingly be fought by every weapon at command. No apparent regard is paid to the fact that the institutions he represents are the foundations of the State, and that such merely destructive activities immediately react on the prosperity of the community. There is a tendency to seek the fulfillment of the new idea, not by the cumulative effect of sound constructive work, but by the destruction of the present system on which, until something better is evolved, the livelihood of the whole nation depends. In other words, these doctrinaries are consciously at war with the present organization of industry, and their attitude is expressed in a general encouragement of mistrust, impatience, antagonism, and complete indifference to productive efficiency. It would not be true to say that the bulk of the workers are dominated by this idea, but the application of their unreasoned philosophy leads to very much the same thing.

The past six years have witnessed a tremendous development in the status of labor against which there is nothing to be urged. Wages have largely increased, hours of work have been lessened, and the organization of the workers has been enormously strengthened. But with this new sense and experience of power, certain irresponsibilities have resulted which are most disastrous. In a certain industry, for example, subsidized by the taxpayers, the wages have increased 300 per cent; and individual output, it is alleged, has fallen at least 50 per cent. Most of the great trade unions of the country have declared against working a system of payment by result in spite of the most complete safeguard for the inefficient, and in spite of the fact that this system is beyond all question the most effective to induce production and in principle the most equitable to all concerned. Over a considerable period there has been a national embargo on the working of overtime. Avoidable overtime is an evil which cannot be defended. Overtime on a key operation is on occasion an essential, which it is sheer folly in these times to refuse. Overtime to pour a casting to provide work for a gang of men, or to release a cargo steamer to catch a tide, are instances which would have been acknowledged, had there been any disposition to examine the question on its merits; and still demand follows demand for further and increased advantages.

These circumstances are not referred to by way of recrimination, but because they indicate an attitude of mind. They indicate that the workers do not believe that the country is now in such a position that only greatly increased production can save it from industrial disaster. They do not realize that their well-being can only be assured, provided they are able to exchange freely the manufactured articles they produce for the commodities which they must obtain from other peoples; and that, too, in competition with other manufacturing communities similarly situated. They do not appreciate the fact that the cost and bulk of our production must determine the cost and bulk of those things we desire to import for our maintenance or comfort, and that to this extent the cost and standard of living would appear to be factors largely governed by themselves. They are holding out both hands to grasp at privilege and do not count the cost.

This in brief is the pressing problem with which industrial statesmanship is faced. Many of the industries of the country, if not already there, are rapidly drifting into a position which is economically unsound. If the tendency to take out of industry more than is put into it is further pursued, or if the destructive theory is more extensively accepted by the workers that the debilitation of the present organization is, in itself, something desirable to achieve, there is before the country a period of grave economic crisis and social danger. Industry cannot be subsidized indefinitely by the taxpayers, or carried on out of capital resources, and unless the nation settles down to work and produces what it seeks to enjoy, it cannot escape the disaster resulting from the defiance of such elementary need. It is desirable that some other means than bitter experience be found of demonstrating that is is useless to evolve theories of distribution if nothing exists to distribute, because in the times we face, disillusionment and distress are evils that will not live alone.

Now the probability is that the situation has not got beyond a point where it can be regulated, provided the mind of industry addresses itself to the problem. A remarkable combination of circumstances, due to the war, and necessitating continuous employment at whatever cost, has given the workers an unbalanced perspective and created illusions which, in the nature of things, cannot be maintained. It is unthinkable that a usually well-balanced community would commit economic suicide if it realized what was taking place.

The average British workman is [illegible] preeminently a sane and reason[illegible] to meet a necessity which he [illegible]. [illegible] educative propaganda therefore is [illegible].

It is a first necessity that he should [illegible] that he is getting a "square deal" [illegible] only be approached through his [illegible]. It has been a striking fact that in the [illegible] ing industry, excessive demands [illegible] larly, on the ground that the [illegible] ment were improper, so much as [illegible] desired a larger share of the profits [illegible] employers were making. The cotton [illegible] witnessed a financial manipulation [illegible] realized a capital appreciation of [illegible] be supposed that the spinners will [illegible] they have shared in the spoils? The plain [illegible] are now strong enough to exact [illegible] profits of production and it would [illegible] clear that the employer shares [illegible] employers attempt to create an [illegible] reciprocated good will can at least [illegible].

If two parties are inseparably associated [illegible] arise which cannot be ignored, peace [illegible] by frank and friendly discussion. In this connection the National Industrial Conference was a splendid conception and it is a great misfortune that its potentialities have not been more fully developed. But the individual can do a great deal. Those acquainted with the problems of management should, wherever possible, establish personal contact with the worker and keep him in touch with the world factors affecting the particular product on which he is engaged. But one of the main difficulties of laying an effective case before the men lies in the fact that in a large workshop it is only possible for the directorial heads to get into personal contact with a very few individuals. These delegates may be perfectly honest, but it is unreasonable to expect them when reporting discussions to accept the employer's outlook and represent it in convincing fashion. The shop steward cannot be regarded as the best means of propagating information which the employer believes the individual workers ought to know.

Some attempt, too, must be made to demonstrate to the public at large the governing factors on economic questions. It has not been realized, for instance, that the tremendous increase in the price of labor and raw material, is making it impossible for the country to finance the volume of output of which it is capable, with a consequent reduction in the purchasing power of the nation. It is not understood that every increase now made is simply making the evil more pronounced, and defeating the very purpose for which it was designed. Subsidized houses, transport, coal and other commodities have been accepted with the utmost complacency, and a feeling has been created that such political strategies can be substituted for work. There has been no real insistence on the fact that the primary duty at the moment is to produce in the utmost quantity at the cheapest rate, and that instead of the studied indifference experienced, the whole of the community should be mobilized to this end.

The time has come, too, when the mischievous interference by Government Departments in industrial [illegible] should be considerably curtailed. It cannot be eliminated because the Government is responsible for the maintenance of law and order in the realm; it is the custodian of the interests of those not directly affected by a dispute and as such, is an interested party whose voice [illegible] must be heard. But it has been proved on many occasions that a Government is too susceptible to outside considerations. Expedience is the only recognizable note of its industrial policy. And where it is quite well known that one party to a discussion will always give way to expediency, the other may well be expected to remain obdurate. The workers are clearly entitled to receive from industry the greatest advantage which industry can afford, but this line cannot be overstepped without grave menace to themselves. There comes a time, therefore, when necessity must govern, and this point can best be determined by the directorial heads of industry on the one side and the trade unions on the other.

Finally, our industrial and social difficulties can be eased by the efficiency of the employer. He it is who in a very real sense has to keep running the wheels of industry and on [illegible] arity of the [illegible] in the art of production [illegible]

It is necessary that employers should [illegible] practice of the open door [illegible] but confidence.

Results of South African Experiences with Narrow Gage Railways

[illegible]

Considerable experience has been acquired in South Africa during the past decade with regard to the operation of narrow gage tracks. Though the main network of British South Africa is laid to a gage of 3 ft. 6 in., which is itself considered as narrow in countries where the European and North American standard prevails, the expression "narrow gage" as used in South Africa, is applied only to lines of 2 ft. or 2 ft. 6 in. gage. Of this class there are just under 700 miles in operation (exclusive of lines in the South West Africa Protectorate), representing not quite 7 per cent of the total railway mileage of the Union. These narrow gage lines vary in length from the Port Elizabeth—Avontuur Railway, 177 miles long, to short spurs of about 25 miles.

Sir William Hoy's Opinion.—Sir William Hoy, the general manager of the South African Railways, in the course of an analysis of the advantages and disadvantages of narrow gage systems, published in the June number of the official South African Journal of Industries, has little to say in favor of narrow gage lines. While he admits that the cheaper first cost in many cases cannot be gainsaid he brings forward a formidable series of objections relating to the operating side. These are, in brief, the impossibility of pooling rolling stock between the narrow gage line and the main line—a serious drawback when, as is usually the case with agricultural districts, the traffic is of a seasonal character, inability to employ old main line engines and rolling stock on narrow gage feeders, the necessity for providing repair shops and engine sheds for each narrow gage line, the expense and delays occasioned by transshipment at junctions, and the impossibility of through running of trains.

Sir William Hoy is not opposed to the construction of short narrow gage branches in cases where they are never likely to be extended to link up with another main line. In such cases, however, the lines should be laid and worked rather as tramways than light railways. The track should be of 20 lb. rails, and no stations or staff should be provided other than the driver of the train who, with the assistance of one or two natives, can attend to the entire operation of the line. The residents of the district served should themselves load and unload the cars.

Taking seven narrow gage lines, aggregating 372 miles in length, the average capital cost per mile was £3,16[illegible] ranging from £[illegible] in the case of the Pienaars River—Settlers line to £[illegible] for the Port Shepstone—Paddock Railway. The average cost for 13 light standard (3 ft. 6 in.) gage branches, aggregating [illegible] miles, was £[illegible],177 per mile. Of these the greatest cost, £8,17[illegible] per mile, which is considerably [illegible] than the most expensive of the narrow gage railways, but as the standard gage line in question runs through comparatively flat country while the narrow gage railway traverses much more broken ground, the two cases are hardly comparable.

In the matter of relative cost of operation the average working expenditure (including depreciation and interest charges at 5½ per cent) for the seven narrow gage lines was [illegible]d per ton mile. In the case of the 13 standard gage lines the corresponding figure was [illegible].30d. On the other hand the average cost per train mile was 6s. 8d. and 7s. 7d., respectively. These figures show that while the cost of running a narrow-gage train was slightly below that of a standard gage train the greater loads carried by the latter reduced the actual cost of moving goods to almost 1d. per ton mile below the amount for narrow-gage lines.

The Manufacture of Concrete Pipes by the "Hume" Centrifugal Process

By W. WOLSTENHOLME.

From The Journal of the South African Institution of Engineers, May, 1920.

Discarded wire ropes are generally used for the purpose of reinforcement. These ropes are carefully selected.

The ropes are cut in suitable lengths and annealed. The annealing removes the grease and makes the wire ductile so that it can conveniently be made up in reinforcing cages. The rope is next unstranded and the individual wires wound on the spools and placed on jennies behind the reinforcement weaving machines. The reinforcement weaving machines are fitted with collapsible drums and the wire is wound on to these drums first spirally and then longitudinally. For high pressure pipes it may be necessary to have several layers of spiral wire and several layers of longitudinal wires. See Fig. 1. These layers are pitched automatically so that each falls between the preceding layer. For low pressure pipes it is usual to arrange the wire so that two spiral layers and one set of longitudinal wires are sufficient. When the case is completed the drum is collapsed and the cage withdrawn. The cage is then placed in the pipe mould.

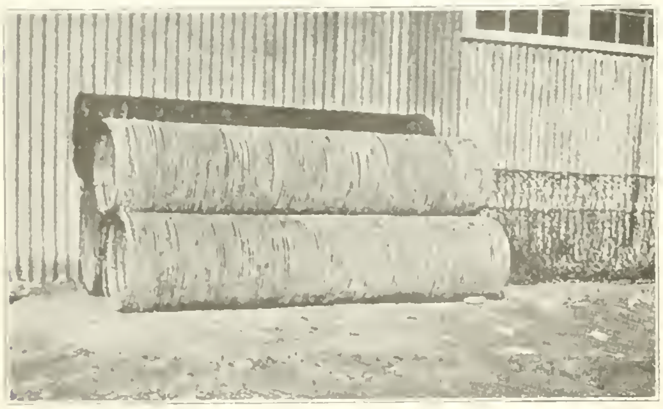


Fig. 1—Reinforcement for 18-In. Pipes, 180-Lb. Pressure.

The pipe moulds are usually made of light steel sheet, galvanized preferably, with cast iron end rings. The end rings serve a treble purpose as they secure the steel casing, form the thickness of the wall of the finished pipe and provide the running treads which come in frictional contact with the revolving discs of the moulding machine. See Fig. 2.

The moulding machines are of simple design. The frame consists of two longitudinal girders in which are mounted the bearings and shafts. Discs are keyed on the end of each shaft suitably spaced to receive the end rings of the pipe mould. Variable speeds are obtained by long cone pulleys, by stop pulleys or by variable speed motors.

The driving power operates the first disc shaft only and each succeeding disc shaft is operated by the frictional contact of the pipe mould. On the small moulding machine six pipes, and on the larger machines four pipes are made at the same time. (Fig. 3.)

The original machines were obtained from Australia. These machines were arranged to make three pipes at one time up to 15 in diameter and two pipes at one time in the larger sizes In re-designing the machines to make six pipes at one time on the small machines, and four pipes at one time on the larger machines. The results have been entirely satisfactory.

The pipe moulds are placed in position on the discs and the moulding machine then commences to revolve slowly. The concrete is thrown into the moulds until the required amount is furnished. The centrifugal force spreads the concrete evenly through the length of the mould and the operator can see when sufficient has been supplied. The machine is then speeded up and the water in the concrete rapidly extracted by the centrifugal force. This water accumulates on the inner surface of the pipes and after a short time the machine is stopped, the removable water rings which are fitted into the mould ends removed, and the water allowed to run out. The machine is again started up and run at high speed and the pipe dried out. If an exceptionally smooth internal surface is desired, a polishing bar is firmly applied to the surface of the concrete. This bar usually consists of a polished piece of steel pipe and is pressed down on to the concrete.

Another method of smoothing the surface is by the insertion of a steel cylinder somewhat smaller in outside diameter than the bore of the concrete pipes. Mounted longitudinally on the surface of the cylinder are a series of sheet iron strips which act as trowels. These trowels come in contact with the concrete and tend to smooth the surface. The cylinder may be revolved in the opposite direction to the pipe or may be stationary.

The time required to complete a batch of pipes varies with the size of the pipe and the quality of concrete used. Generally speaking, six 4-in. or 6-in. diameter pipes can be completed in 8 to 9 minutes, while four 15-in. or 18-in. diameter pipes require about 15 minutes. Pipes of 48-in. or 60-in. diameter can be finished in about 20 minutes.

Pipes up to 15 in. diameter are usually made in 6 ft. 0 in. lengths, and 18 in. to 72 in. diameter in 8 ft. 0 in. lengths. These lengths may be subdivided into shorter lengths by placing a steel dividing ring in the mould.

When the pipes are completed on the moulding machine they are carefully rolled into the steaming chamber and left in a temperature of about 200° F. for 12 hours.

They are then removed from the moulds and placed overhead in water for at least one week if high pressure pipes, and for a shorter period if for low pressure or drainage purposes. The pipes are then stacked for a further period, at least four weeks, before delivery to purchaser.

Pipe collars are made in exactly the same manner as pipes, exceptiug that thin steel division or parting plates are placed in the mould at intervals of 6 in. or 9 in.

As already mentioned, at the factory we use large quantities of steel wire obtained from selected wire ropes, for the reinforcement. For very high pressures new steel wire of high tensile strength may be used, while for the highest pressures a sheet steel liner is embedded in the concrete. Using the latter method of reinforcement a test pressure of 750 lb. per square inch has been obtained.

We find, from experience, that for high pressure pipes a mixture of 2 parts washed and screened sand and 1 part cement gives the best results, while for low pressure pipes 2 parts of crushed waste rock (from the mines), 2 parts sand and 1 part cement gives good results.

Tests and Working Results.—A certain percentage of all pressure pipes are tested regularly. With small diameter pipes, say, up to 9 in., we regularly get up to 300 or 350 lb. per square inch. With large diameters, say, 18 in. and 24 in., we have tested up to 210 lb. per square inch. These figures are obtained on pipes with reinforcements made from the wire taken from discarded wire ropes.

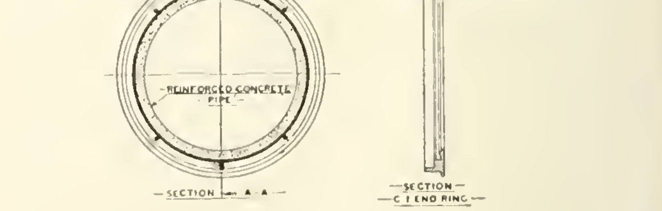


Fig. 2—Standard Pipe Mold.

I might mention here that the quantity of reinforcement is carefully calculated and arranged so that at working pressure the wire is never stressed higher than one-fourth of the elastic limit of the wire used. Generally, a lower stress is taken so as to have ample margin to resist shock loads due to water hammer, etc. The strength of concrete in tension is not taken into account, though as a matter of fact, such strength adds further to the safety of the pipe. In testing concrete pipes made by the "Hume" process and in actual practice under working conditions, it is found that when an excessive overload is applied the pipes sweat heavily and so release the excessive pressure. The pipe may eventually develop slight cracks, but will not burst. Under the worst circumstances the pipes will carry water again when pressure is back to normal generally without leakage, but in any case they will carry water until such time as defective pipes can be replaced.

We have an 18-in. diameter pipe at the factory made for 100 lb. per square-inch pressure. We tested with a handpump to see what this pipe would carry. At 210 lb. it sweated heavily and it was not possible to raise this pressure. Slight longitudinal cracks were visible under the overload test. At 100 lb. pressure the pipe is tight today, although it is six months since the overload test was made.

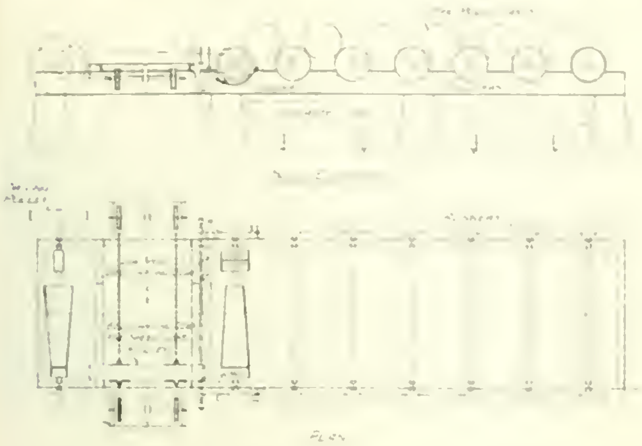


Fig. 3—Molding Machine for Six Pipes

The joints are made in a simple and efficient manner. A collar reinforced in the same manner as the pipe is slipped over the joint. The space between the outside of pipe and inside of collar is rammed up with a mixture of 1 sand and 1 cement. For high pressure joints, in addition to the ramming, a plastic substance of special mixture is filled into a cavity formed in each pipe end. The pipe ends are tightly butted together with the plastic material completely filling the cavity. When the pressure is applied inside of the pipe any leakage of water at the joints tends to displace the plastic and forces it more tightly into position in the cavity and so prevents the leakage reaching the ramming in the collar. The plastic is of peculiar composition and retains its plastic state for many years.

Other methods of jointing may be and have been used with success. For instance, the ordinary Kimberley collar caulked with lead has been used in many cases, faucet and socket joints have been used, but results are unsatisfactory for many reasons. The joints are considerably stronger than the pipe as the reinforced collar binds the pipe end all around.

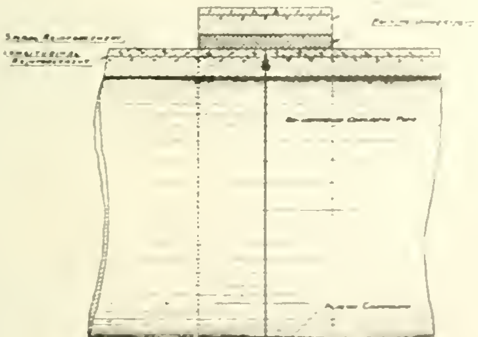


Fig. 4—Standard Pipe Joint.

In addition to the use of concrete pipes for conveying high and low pressure water the centrifugal process has made it impossible to make concrete pipes sufficiently dense to carry sewage without the least risk. The centrifugal process had also made it possible to make exceedingly thin pipes. Such pipes have been supplied for carrying air for ventilation purposes underground on the mines. Pipes of 12 in. to 18 in. diameter are regularly made ¼ in. to ⅜ in. thick. These pipes are reinforced with ordinary wire netting of 1½ in. or 2 in. mesh. These pipes are also in use as smokestacks. Thousands of feet are in use carrying electric cables for post office telephone service, etc.

Then again, special pipes are made for lining bore holes, wells, etc. Culvert pipes have been supplied in large quantities and are rapidly replacing the "box" form built in situ. Tanks for the conservation of rainwater and for the storage of mealies and ensilage are regularly made.

Steel or iron pipes, damaged by corrosion, are lined with concrete, the mixture being spun in centrifugally.

One of the latest uses for concrete pipes (used as tanks) is for the storage of wine, spirits and beers. The centrifugal process makes it possible economically to use concrete for these purposes as the receptacles can be made light in weight and of great strength.

Experiences with Metal Ties on Indian Railways

From the Railway Engineer, London, August, 19[illegible]

On March 20, 1887, a paper was read before the Institution of Engineérs and Shipbuilders at Glasgow on metal sleepers for railways. In this it was stated that many wrought iron sleepers both transverse and longitudinal (such as the "Hilf") had been tried, and that Greave speroidal cast-iron bowl sleepers had been in use for some years. At that time there were eight hundred miles of these sleepers on the Madras Railway and the cost of them, as compared with jungle wood sleepers, had been found, in five years, to be as three to one, in favor of the bowls and pots. These were packed by hand with sand. On the Scinde, Punjaub & Delhi Railway the general opinion of the engineers, based upon the experience of ten years, was decidedly favorable to iron bowls in preference to wooden sleepers. These were packed with "poor brick earth" being stuff too sandy to cake and not sandy enough to blow away. They had also been laid on the Bombay, Baroda & Central India and on the Great Indian Peninsula Railways and since 1850 in Egypt. The Great Indian Peninsula bowls are oval, packed with hard stone carefully broken to a uniform size of 2 cubic inches. On the Eastern Bengal Railway the Goalundo extension had then been laid for five years with these bowls. The bowls showed a life of 89 years as against a life of 16½ years of the wooden sleepers.

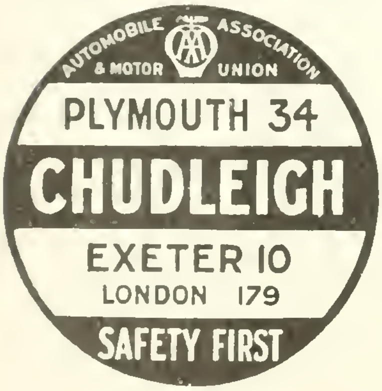
The paper was quoted extensively and with approval in the report of the U. S. Department of Agriculture on the substitution of metal for wood in railroad ties in 1890. In the last number to hand of an Indian technical journal there is an article on the enquiry into the life of a cast-iron sleeper road laid on the Madras Railway since 1861 on which the Greaves bowls have been used up to the present time. After 38 years, the author of the article, which had been in charge all the time, compared the price which might be paid for a pair of pots, etc., to make them equal in final capital cost, with hardwood sleepers as over two to one, taking the life of the pots at 60 years only and that of the hard wood sleepers at 14 years. The writer concludes, from figures he gives, that (a) An iron road is cheaper than a wooden one; (b) it is much more durable; (c) the cost of maintenance and annual costs are less; (d) the gauge is well kept without difficulty; (e) cast-iron sleepers, removed owing to cracks or breakage, can be re-cast at the cost of labor only, by the locomotive department at Rs. 1 6a. 6p. each; the price allowed for them as old metal being Rs. 20 a ton or Rs. 1 each. O nthe East Indian Railway the Denham-Olpherts sleepers have been laid for over 40 years and rather later the wrought iron pea pod sleepers have been extensively laid down, the latter especially not only in India, but in very many other tropical climates. In the May number of the International Railway Association's Bulletin an article is given by M. A. Perey on the renewal and depreciation of permanent way material, in which it is mentioned that many miles of the Swiss railways are laid on metal sleepers. M. Perey's figures, resulting from his careful and elaborate investigation, go to show the great ultimate saving due to the substitution of steel for iron rails, and of metal for wooden sleepers—even when the latter are cheap and easily procurable. Sir Guilford Molesworth, in his lectures at Chatham, pointed out the great waste of good ballast that so often occurs when it is laid on the forming before the banks have settled. This occurs especially on high banks composed of loose stuff not consolidated; at the back-ings of bridge-abutments, and in the fillings over culverts and at other gaps left in the embankments, which are the last to be made good

Standardized Road Signs in Great Britain

From The Surveyor (London)

For many years past the Automobile Association has, in co-operation with local authorities, erected road signs, but in all cases these signs have only been granted after careful inspection by the Automobile Association road staff, and an assurance that they have been really necessary for indicating hidden dangers. One result of this careful program is that many highway authorities who previously supported the "red triangle" and its variations now prefer Automobile Association road signs, and always make a point of applying for them

The new road sign scheme of the Automobile Association is intended to avoid multiplication of road signs, and to secure continuity and standardization throughout the country. The scheme involves the supply of a very large number of these new pattern signs, as illustration attached. They will denote the entrance to towns and villages, and will be in yellow and black—the best colors for visibility—and give the name of the town or village with accurate distances from London and other places. They will emphasize the need for care by bearing in every case the words "Safety First," and if erected on the near side of the road before entering a populous place they should certainly be more effective than many existing signs which bear varied requests to drive slowly, etc, etc. The reasonable motorist who is driving in a district strange to him is predisposed to and does not take notice of warnings which define a specific danger; the unreasonable motorist, while he is not likely to pay any regard to a request merely to "drive slowly," may be expected to drive cautiously when he is definitely warned of danger ahead.



Village Sign.

The new road signs will be erected on a uniform basis, and, as already stated, it is hoped that every county or borough in the country will recognize the efficiency which must follow a uniform system of road signs. If all counties and boroughs do not lend their co-operation the efficiency of this Automobile Association road sign scheme, which is based on national lines, will be curtailed. It is therefore hoped that every responsible authority throughout the country will co-operate in the association's campaign for a fixed system of road signs, and thereby assist in putting an end to the present multiplicity of signs, which multiplicity has tended to decrease their effectiveness as road warnings. The signs will be issued free of cost, subject to the highway authorities erecting them. The best point for their erection is on the near side of the road entering the city, town, village, or hamlet. Main roads will receive first attention, and wherever possible the whole length of a road will be dealt with in preference to a particular district.

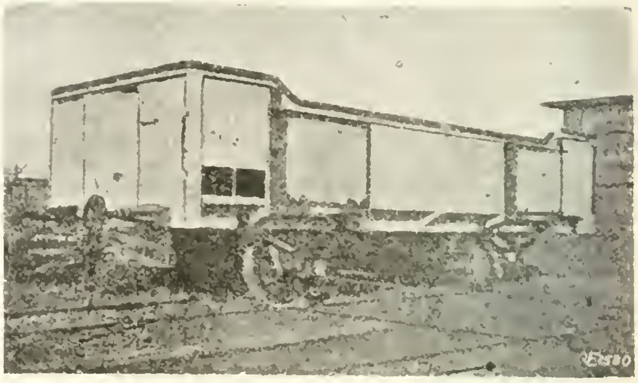
The following are details concerning the lettering on the signs. The distance to London will be at the bottom, and will be on every sign unless there are exceptional reasons to the contrary (Ireland will have Dublin; Scotland, London). Distances to London will be on the old milestone terminals, i. e., London Bridge, Westminster Bridge, Hyde Park Corner, Marble Arch, Hicks Hall, Shoreditch Church, and Whitechapel Church. In taking these terminal points due regard will be given to the fact that since the milestones were erected new coach roads have been made which in some cases have shortened distances. In this connection it is proposed to secure the co-operation of county and borough surveyors, and arrive at the actual distances by reference to their 25-in. ordnance maps

Test of Austrian Reinforced Concrete Railway Car

From Beton u. Eisen.

A recent official test of an Austrian railway car built of concrete throws an interesting light on the strength of this new application of reinforced concrete.

The car, of 30 tons nominal capacity, filled with wet rock weighing 31.6 tons, was hauled at the normal speed, first alone and afterwards as the first of a train of 15 loaded cars; it was stopped suddenly by applying the brakes. It was afterwards hauled coupled in front of 15 other cars and was pushed at more than normal speed until it collided with a stationary train, but without much harm, though the shock was so great that the stationary train was seriously damaged. The actual defects revealed on minute inspection were: (1) a previously existing crack was slightly enlarged; (2) a new crack was found on the front of the car; (3) a little spalling had occurred on the front; (4) two cracks at the corners between the end and side; (5) a crack at the crank pin above the side door; and (6) various hair cracks in the beam under the bearing.



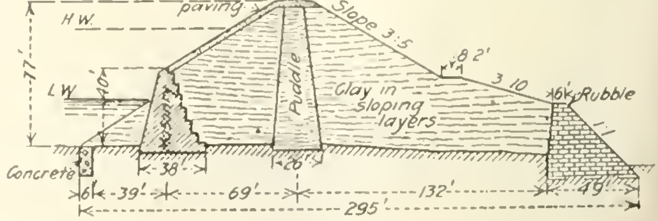
Railway Car Built of Reinforced Concrete.

These defects are attributed to errors in construction: (1) and (2) to an unsuitable position of the reinforcement in front of the truck, (3) to the use of Rabitz expanded metal, (4) to the corners not being sufficiently rounded, and (5) to a weak place in the structure which can easily be remedied in future trucks. The slight hair cracks are of no importance. As none of the defects are serious, the car is to be repaired and put into use.

The results of the test have so far exceeded expectations that a number of German and Austrian firms are interesting themselves in the subject and propose to build similar cars of reinforced concrete.

Earth Filled Dam With Masonry Retaining Walls

The Paquli de Lagastrello dam of an hydro electric project in the Enza Valley, near Parma, Italy, has several interesting features. Owing to local conditions it was not possible to construct a masonry structure, but as there was available an abundance of excellent clay an earth filled dam with marginal masonry retaining walls was built. The main section of the dam was constructed in thin clay layers inclined upward from the center puddle wall. The dam has a length of 560 ft. at the top, an extreme bottom width of 77 ft. and a height of 77 ft. The greatest depth of the pond is 69 ft. The dam is described in Vol. 1, 1920, of Annales des Ponts et Chaussees, Paris.



Cross-Section of Pasquli de Lagastrello Dam.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 403 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Material
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $1.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., OCTOBER 6, 1920. Number 14.

Ford's Fallacy: "The War Is Over and War Prices Should Be Over"

Henry Ford has startled the business world not so much by announcing a return to prewar prices for his motor cars as by the sweeping statement that all prices should be lowered to the prewar level. He says:

> The war is over and it is time war prices were over. There is no sense or wisdom in trying to maintain an artificial standard of values. For the best interests of all it is time that a real practical move was made to bring the business of the country and the life of the country down to normal.

Commenting editorially upon this announcement the New York Sun remarks:

> And now he (Ford) has given us fresh evidence of his vision as a matchless distributor of the products of his mammoth workshops in the drastic slashing of prices to pre-war levels. In this stroke Henry Ford has pointed the way for all other producers, all other merchants. The country is headed for lower prices—prewar prices or prices thereabouts.
>
> No man, no body of men, no association of interests working in collusion, or corporation however gigantic can hold up the unnatural and exorbitant war prices. What Henry Ford has done in his far reaching vision other men must do or they cannot survive.

Scores of similar editorial articles have appeared during the past 10 days, all very optimistic as to an immediate return to prewar prices, and therefore exceedingly misleading. The public is prone to listen with deference to the utterance of any highly successful business man when he speaks on financial matters, and particularly so when he seems to be sympathetic with public desires. Few people pause to consider whether the business man who acts as economic prophet has studied economics outside the narrow field of his own business. Yet experience should have taught us all that even the most successful business men are often woefully ignorant of many economic laws and data. We have in Mr. Ford's statement above quoted a striking example of such ignorance. Had he been familiar with the history of general price changes he would never have made so foolish a statement as "The war is over and it is time war prices were over." If this is true generalization it is as applicable to the great wars of the past as to the recent world war, yet there is not a single modern instance of a great war that was followed by a quick return to prewar prices.

Our civil war ended in 1865 with the wholesale commodity index price at 172, as compared with 86 in 1861; yet it was not till 1879 that the price index had fallen to the prewar level, and the decline had been relatively slow during the preceding 12 years. During the first two years following the price peak of 1865, the price index fell to 131, or about 25 per cent, and thereafter dropped very slowly.

Suppose some Henry Ford of 1865 had said what he has just said, and people had generally accepted his statement as true, would there not have been a sorry lot of solemn waiters for the good old prices of 1861? Yes, a 14-year lot of wrathful waiters.

Able as Mr. Ford is as a manufacturer and merchant, his ignorance of industrial history is fully as profound as his admitted ignorance of political history. Yet without a knowledge of industrial history, particularly with reference to general changes in price levels, no man can give worth while advice as to the future of price levels. To attempt to advise the nation about future price levels without studying the history of past price levels is on all fours with an attempt to predict an eclipse without having studied the records of astronomy.

In Mr. Gillette's recent (Apr. 7) 20-page article on price levels it was shown that the two main factors that had operated to increase commodity prices were increase in money per capita and increase in the rate of money turnover. It was shown that when the present high rate of money turnover becomes normal, the amount of money per capita will still be 66 per cent above the prewar level and that consequently, commodity prices will not decline below a level of 1.66 times the prewar level of 1913 for many years to come. The present decline in wholesale commodity prices has gone far enough to reduce the price index to 250 for August, as compared with 100 for the year 1913. Hence there will have to be a further shrinkage of about 33 per cent, or one-third, before average commodity prices will reach "the new plateau of prices," namely, when the index price is 150. This may occur in a few months or it may take two years as it did after our civil war.

Returning to the prices of Mr. Ford's own products it will be well to compare the following:

[illegible]	New price.	Old price.
Touring car with electric starter	[illegible]	$[illegible]0
Runabout with electric starter	[illegible]	625
Sedan with electric starter and demountable rims	7[illegible]	975
Coupe with electric starter and demountable rims	[illegible]	850
Model T Chassis	[illegible]	5[illegible]5
One-ton truck chassis (pneumatic [illegible]) [illegible]	[illegible]	640
Fordson tractor	[illegible]	850

It will be seen that his average price reduction is only about 20 per cent, which is a long cry from the 60 per cent that average wholesale commodity prices would have to drop to get back to the prewar level. In short, Mr. Ford, who had accumulated a vast fortune selling motor cars prior to the war, proposes to reduce his war prices 20 per cent, and coincidently invites the average American farmer, manufacturer and merchant to write down their prices 60 per cent! Further comment seems superfluous.

The Federal Highway Council Meeting at Akron

The two-day session of the Federal Highway Council at Akron, Ohio, last week, was primarily a conclave of committees. Nine committees met separately and jointly to discuss highway problems and to render reports. There was consequently little in the way of technical papers, but much in the way of practical suggestion, particularly as to how to secure more money for highway improvement.

One of the most suggestive as well as interesting features of the convention was a five-reel film entitled, "Virginia's New Hour." This film was made under the direction of James W. Brooks, Director of the Educational Bureau of the Federal Highway Council. It is not only a moving history of the evolution of highway transportation but a visualized exposition of the economy of better roads. The film has been in great demand by moving picture houses in Virginia, and without doubt has served to persuade thousands of voters to support the state highway bond issue. The Federal Highway Council is prepared to assist other states in similar manner to educate the people to the need of expending large sums of money for roads.

Mr. Brooks has prepared a 16-page booklet entitled "Making Highways Pay," which can be advantageously circulated wherever voters need persuasion as to the economic advisability of improving roads.

Abstracts of committee reports will be in our next Road and Street Issue.

Mr. S. M. Williams, Chairman of the Officers and Executive Committee, is to be congratulated upon the success of this convention.

A Plea for the International Road Congress

The last International Road Congress was held in London in 1913. In another column Prof. Blanchard discusses the holding of the next congress in America in 1922. It is not too early to begin the campaign of securing the support for this project by all American highway engineers and officials.

Among the things to be accomplished as speedily as possible is the securing of the support of our federal government through affiliation as a member of the Permanent International Association of Road Congresses.

There is perhaps no subject of political importance that lends itself better to international exchange of experience than the subject of roads. Now that motor vehicles are coming so rapidly into universal use, it is more evident than ever that highway transport problems in different countries are essentially the same. Therefore a periodic congress of highway engineers from all countries must inevitably result in great benefit to some countries and some benefit to every country.

Mr. S. T. Henry, who has just returned from an eight months' trip through South America, told the editor at the Federal Highway Council meeting last week that he found almost no good roads in South America aside from some 300 miles in one district. If civil engineers from South America were sent by their governments to a highway congress in America, they, at least, could not fail to secure many valuable ideas; but, what is equally important, would become charged with enthusiasm for highway betterment in their countries. This enthusiasm they would impart to public officials, to newspaper editors and others.

This much as a suggestion of what South America would gain from us. Our immediate gain from them would be the profit from greater sales of road building machinery and motor vehicles.

France and England may not be able to teach us a great deal about highway design, construction and maintenance, but let us not be so egotistic as to think they can teach us nothing. We have learned much from them in the past, and it is beyond belief that we shall learn no more from them in the future. We are in grave danger of regarding ourselves as the "know it all" nation. Nothing will be so apt to render us immune from the insidious attacks of bigheaditis as an occasional vaccination with the experience of other peoples. Let us by all means support any project that will bring us in contact with the thinking men of other lands.

Why Civil Engineers Should Formulate Economic Public Policies and Programs

For the first seven months of 1920 the sales of city bonds totaled about $412,000,000, as compared with $388,000,000 for the same period in 1919. Bearing in mind that a dollar will now buy less than half what it would buy in 1914, the recent sales of municipal bonds are very discouraging.

Bond interest rates now average about 60 per cent above prewar rates for bonds that are not tax exempt and that are sold at par. As explained fully in our issue of Sept. 22, there is no hope of a rapid decline in bond interest rates; but many city officials are ignorant of the economic laws that control interest rates, and consequently are holding up municipal bond issues in the vain hope that lower interest rates will be securable in the near future. Some cities are prevented by law from paying more than 5 per cent interest on bonds. Municipal improvements in those places will be held up until those restrictive laws are changed. What are civil engineers doing toward persuading the public such laws need revision?

The time has come for civil engineers to take leadership in solving the broader problems of economics, and in making the public realize that engineers are competent to solve such problems. Among these general economic problems none is more important today than the problem of average prices—average commodity prices, and average bond prices. In another editorial we indicate why business men so seldom solve these broad economic problems correctly. An unexampled opportunity presents itself to engineers to study the history of price changes, the causes of those changes, and to derive correct theories with which to forecast future changes within reasonable limits. Having equipped themselves with adequate information on these matters, engineers should be able to persuade the leading men in each city to advocate the economic plans submitted by engineers. It is not enough for civil engineers to design economic structures and plants; they must also formulate economic policies for cities, counties and states to follow. What is the use of plans for construction if there is inadequate money with which to construct?

Bidding Prices on Iowa Road Work.—Based on the number of jobs rather than the yardage, average prices on Iowa road work during July were as follows:

Concrete paving, per sq. yd.	$3.90
Excavation for paving, per sq. yd.	.85
Earth excavation, per cu. yd.	.58
Gravel loading and hauling, 1 mile	.90
Each additional ½ mile haul	.26

The So-Called Asphalt Contents of Road Oils

To the Editor: Your issue of Aug. 4 contained a reprint of a paper entitled "The So-called Asphalt Contents of Road Oils," which was presented by the authors, Messrs. Anderton & Taylor, at the 23d annual meeting of the American Society for Testing Materials.

Inasmuch as this paper apparently carries the weight of the Department of Agriculture behind it and expresses opinions contrary to those held by many engineers, including the writer, it appears unfortunate that the discussion which followed the reading of the paper was not also presented in your issue. A brief summary of some of the points brought out in the discussion referred to may be of interest to your readers.

The authors, in their paper, describe the materials experimented with and the tests they made upon them and then draw certain conclusions from their work. Conclusion No. 1 states: "That with a given type of oil the consistency will indicate the percentage of asphalt," and this is substantiated by a graph showing the relation between the asphalt contents of Mexican road oils and their specific viscosity. Now there are two distinct types of Mexican crude oil imported into this country; the so-called light crude of approximately 20 Be. gravity, and the Panuco or heavy crude of approximately 11.5 Be. gravity. Both of these are used in the manufacture of road oils and some road oils are made from a mixture of them.

The authors do not state whether the type mentioned in the conclusion cited includes only one or both of these oils. As a matter of fact, the relation which exists between the specific viscosity and asphalt contents of straight run products made from the light crude is not the same as that which exists in products similarly made from the heavy crude. This is readily seen from the following:

TABLE I.—Specific Viscosity and Asphalt Contents of Straight Run Road Oils Made from Light and Heavy Mexican Crude

Specific Viscosity at 212 F.	Asphalt Contents (100 Pen.)	Source
2.5	58.1%	Light crude
12.8	75.0%	Heavy crude
17.2	79.2%	Light crude
21.3	75.0%	Heavy crude
30.3	79.5%	Heavy crude
39.2	82.0%	Light crude.
75.4	92.0%	Light crude.
76.1	86.0%	Heavy crude

An examination of the paper reveals but little information as to the real nature of the Mexican products upon which the graph was founded, i. e., whether made from light or heavy crude and the process of distillation used. If an asphaltic crude is reduced by steam distillation and samples of the residuum are taken at various stages of the distillation, it is perfectly true that there will be a definite relation between specific viscosities and asphalt contents. But this has been known for years and it is no new discovery of the authors. This relationship, however, does not hold good where radically different methods of refining the same crude are followed. The paper closes with the following paragraph: "Summarizing our conclusions, it may be stated that it is our belief that the percentage of asphalt gives no additional information on the suitability of a road oil for a given purpose, which is not adequately shown by the results of other tests, better understood and at the present time well standardized." It is important to note that the authors state that the [illegible] examined of residual petroleums, asphaltic petroleums and oil asphalt cut backs, showed no general relation between the percentage of asphalt and the ordinary test characteristics of the sample (which includes of course specific viscosity) and that the source of the oil has a great influence on the results of the tests. It is also of importance to remember that many of the road oils of commerce come under the above classification.

Now let us put ourselves in the position of an engineer of a municipality purchasing road oil and assume that we are following Messrs. Anderton and Taylor's advice. How are we to ascertain the kind of crude from which the road oil we purchase is manufactured? Are we to take the manufacturer's or jobber's word for it and how are we to prove their statements? Moreover, from the standpoint of the results obtained, how much are we really concerned about it, provided it contains the requisite amount of asphalt of the desired quality? If we are to admit road oils made from different types of crude on the basis proposed by the authors of the paper under discussion, we must establish the relation between specific viscosity and asphalt contents for each type and embody these figures in our specifications and exclude practically everything but straight run products, although many of us believe cut-backs to be much superior. Also, we must bar products made from mixed crudes. Much more might be written upon the subject, but the writer believes that the absurdity of the conclusion cited has been fully proved from the paper itself.

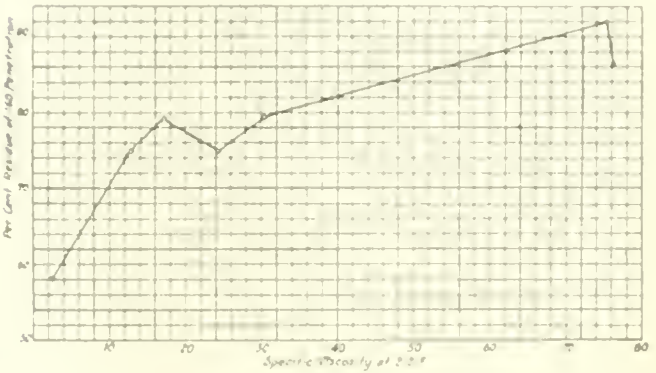


Fig. 1.—Curve Based on Table I

A still more vital point remains to be touched upon which involves a criticism of the specifications for road oils drawn up by the conference of state highway testing engineers and chemists held in Washington at the Bureau of Agriculture in 1917, to which reference is made in the paper under discussion. This criticism refers to the omission in these specifications of any requirements for the character of the asphalt contents. A residue may be obtained by evaporation according to the method described, which, instead of being asphaltic in character and of use as a binding and cementing agent, is distinctly non asphaltic and almost wholly lacking in cementing value. Unless this is guarded against, an oil may be accepted which is utterly worthless as a road binder.

The foregoing table of tests of road oils actually supplied

TABLE II.—ANALYSES OF STRAIGHT RUN ROAD OILS MADE FROM VARIOUS CRUDES.

	1	2	3	4	5	6	7	8	9
Derived from	L't. Mex.	Crude	Heavy Cal.	Crude.	L't Cal	Crude.	Non-Asp. Crude.	Raglan.	Crude.
Sp. Gr. at 60 F.	0.9853	0.9365	[illegible]	1.007	0.981	0.997	0.9285	0.940	0.9732
Flash (closed)	208 F	172 F	[illegible]	428 F	263 F	113 F	230 F	299 F	178 F
Fire	210 F	218 F	118 F	[illegible]	484 F	190 F	146 F	169 F	569 F
Soluble in 76 Be Nap.	86.75%	[illegible]	98.35%	98.20%	98.35%	98.35%	98.20%	96.80%	91.60%
Fixed Carbon	9.50%	6.50%	[illegible]	5.00%	1.00%	3.50%	2.00%	1.50%	7.10%
Loss, 50 gms., 5 hrs., 325 F.	2.92%	11.13%	1.28%	[illegible]	1.05%	0.39%	2.17%	0.65%	0.16%
Sp. Visc. Engler, 212 F.	17.20	[illegible]	[illegible]	4.10	8.70	21.40	2.00	5.00	12.5
Asplt. Contents, 100P.	79.26%	[illegible]	[illegible]	[illegible]	68.50%	75.82%	55.30%	55.10%	42.60%
Asplt. Contents, 50P.									
Analysis of Asphalt. Contents, 50 Pen.	75.66%	[illegible]	[illegible]	[illegible]	[illegible]	72.11%	52.16%		
Penetration at 32 F.	24	22	[illegible]	[illegible]	9	9	33		
Penetration at 77 F	51	57	[illegible]	52	[illegible]	52	52		
Penetration at 115 F.	149	148	[illegible]	80	[illegible]	182	[illegible]		
Soluble in 76 B. Nap.	71.15%	69.75%	90.60%	87.65%	86.95%	90.20%	3.00%		
Fixed Carbon	15.00%	13.00%	9.00%	[illegible]	9.50%	9.00%	11.50%		
Ductility at 77 F	11 cms	12 cms	[illegible]	100 cms	100 cms.	100 cms.	1 cm.		
Character	—	Asphaltic and very cementitious					Greasy; Not cementitious.	Adhesive; Not oily.	Very adhesive.

to a number of municipalities will illustrate some of the points the writer has tried to make in the foregoing. In all cases the kind of crude from which these oils were made has been established beyond any reasonable doubt.

The absence of any constant or definite relationship between specific viscosity and asphalt contents in road oils made from different crudes is clearly shown by the following excerpt from this table in which the road oils have been re-arranged according to specific viscosity:

TABLE III.—Specific Viscosity and Asphalt Contents of Straight Run Road Oils Made from Various Crudes.

Specific Viscosity at 212 F.	Asphalt Contents 100 Pen.	Source.
2.0	55.30%	Non-asphaltic Crude.
2.5	58.07%	Light Mexican Crude.
5.0	65.10%	Kentucky Crude.
8.7	68.50%	Light California Crude.
12.5	92.60%	Kentucky Crude.
13.1	74.65%	Heavy California Crude.
17.2	79.26%	Light Mexican Crude.
21.4	75.82%	Light California Crude.
34.1	87.02%	Heavy California Crude.

Here we find an oil with 21.1 specific viscosity having a lower asphalt content than an oil with 17.2 specific viscosity, and an oil with 12.5 specific viscosity having far higher asphalt contents than any of the series up to 34.1 specific viscosity.

Plotted in a graph, the curve showing relation between asphalt contents and specific viscosity appears as shown in Fig. 2.

Reverting to Table II, we see that the asphalt contents obtained by evaporation in the prescribed manner from oil No. 7, has practically no ductility or cementitiousness and is distinctly greasy. The character of ths residue cannot be predicted from any of the other tests made on this road oil. Its gravity closely approximates that of No. 2. Its naptha soluble contents is almost the same as Nos. 3, 4, 5 and 6. Its fixed carbon closely approaches that of No. 6, as does also its specific viscosity, and yet all these oils yield asphalt residues of good ductility and high cementitiousness. With the exception of the penetration and ductility tests, none of the other tests made on the asphalt contents themselves give any clue to the physical characteristics of this residue. Its naptha soluble and fixed carbon contents are almost the same as No. 1. For this reason the writer believes and strongly urges that a ductility requirement be added to the asphalt content requirement and that both be included in road oil specifications. In view of the foregoing, it would be interesting to learn just what other "better understood" tests, the authors referred to in their concluding paragraph as giving adequate information concerning the suitability of a road oil for a given purpose.

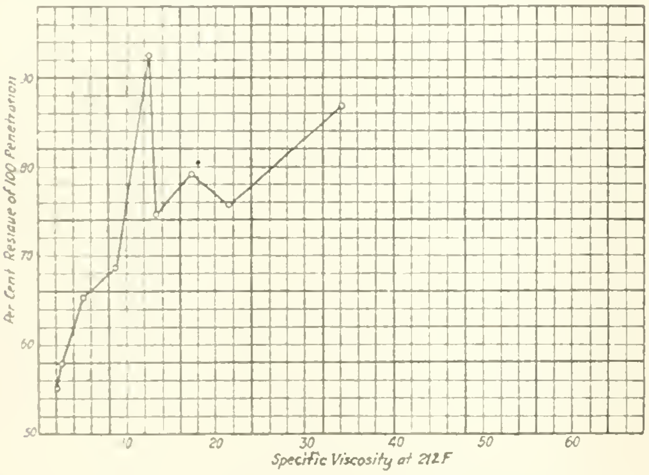


Fig. 2.—Curve Based on Table III.

F. P. SMITH,
New York. Consulting Paving Engineer.

Freight Rates on Construction Materials

To the Editor: My attention has been called to an editorial in the Sept. 1 issue of "Engineering and Contracting," entitled, "Why Wisconsin Road Improvement Has Been Delayed," in which the following statement is made: "Railway officials will naturally be inclined to give preference to freight that yields the largest revenue per car mile, and construction materials do not fall within that class."

This impression seems to be general throughout the engineering and public press. Even railway officials, who should know better, often express similar opinions. The facts in the case do not bear out that there is any logical relationship between the earnings on construction materials and other classes of freight. Especially is this true of mineral aggregates.

Just now, while all business is fraught with uncertainty because of the lack of adequate transportation, it would be well for the public and those most interested to understand the freight rate structure as it exists today and its effect on movement of commodities. They should know that building materials are and have been paying more than their share of the freight charges and with the 40 per cent blanket increase, granted by the Interstate Commerce Commission, the excess over the just share these commodities should bear will be still further augmented. The influence of every one engaged in the construction industry will be needed to correct this injustice and to prevent further throttling of building work because of the restriction to the movement of building materials under excessive rate charges.

The National Association of Sand and Gravel Producers, before the Interstate Commerce Commission said:

> The National Association of Sand and Gravel Producers does not attempt to deny the statement of petitioners in this proceeding, that the revenues derived from the sale of transportation service are inadequate; that there should be an advance in the general level of rates; but we assert emphatically our belief that to secure additional revenue by a blanket advance in all freight rates, without distinction, would be unwise and unjust and cause hardship and injury to many industrial interests. There are three kinds of transportation rates in existence today: Those that are fair, those that are excessive, and those that are preferentially low. We assert as an incontrovertible fact that if the carriers will eliminate all preferential rates by advancing them to a just and reasonable basis, they will not only enhance revenues sufficiently to meet their needs, but will also be able to reduce, to some slight extent at least, the undue burden now weighing heavily on certain producing interests, particularly that of sand and gravel.
>
> There are rates in effect that yield less than 5 ct. per car mile. Not many, of course, as that is the extreme situation; but there are many that yield less than 12 ct. per car mile. As far back as the Five Per Cent Case this Commission called attention to this situation. On page 408, I. C. C. 31, is found the following:
>
> "We suggest that all the railroads in Official Classification territory examine carefully their freight rates, rules and regulations with a view to increasing rates that are found to be clearly unremunerative, and modifying burdensome rules and regulations relative to minimum weights and similar matters where this may justly be done. The compilations prepared by the Commission of answers of carriers to our questions in this proceeding calling for a statement of their earnings on representative traffic discloses many rates which barely yield enough in revenue to pay adequately for the mere use of the equipment. Our compilation also shows that a large proportion of traffic in many commodities is yielding less than 7 ct. per loaded car mile, although the record shows that railroad men ordinarily consider that the average earnings per loaded car mile should be more than twice that amount. Many unremunerative rates had their origin in fierce competition for traffic or under the menace of the big traffic of powerful shippers. Many such rates have doubtless been continued through ignorance of the loss they entail upon the carriers." (Five Per Cent Case.)
>
> On page 418 of the same report is a table listing samples of rates taken from answers filed by carriers, showing net car mile revenue ranging from 2 ct. to 7 ct. Tables on pages 415, 416 and 417 of the same report list many rates yielding less than 10 ct. per car mile.
>
> A compilation from reports made by 41 sand and gravel producing plants, located in various parts of the United States showed: "During the year 1919 the 41 reporting plants shipped 66,913 car loads of sand and gravel. The average haul was 49.31 miles and the average rate 71.4 ct. per ton. In the C. F. A. Class Rate Case before the Indiana Commission in 1917 carriers introduced carefully prepared exhibits showing the average terminal cost of handling less than carload freight to be about $2 per ton and of carload freight about 15 ct. per ton. This includes the combined cost at points of origin and destination. Allowing for the difference in cost between 1917 and 1920, the cost today of handling carload freight at terminals could not exceed 28 ct. per ton. Computing on an operating ratio of 70 per cent, the justified terminal factor of the rate would be 40 ct. per ton. Deducting 40 ct. per ton from 71.4 ct. per ton, the hauling factor of the rate paid on sand and gravel would be 31.4 ct. per ton for 49.31 miles, or 6.4 mills per ton mile, or 32 ct. per car mile.
>
> The Third Class rate, Boston to Chicago, is 75 ct. per 100 lb.

Third class has been found to [illegible] carload freight, 75 ct. per 100 [illegible] cost in 1917 was $2 per ton. That [illegible] per ton which on an operating ratio of 70 [illegible] the terminal factor in the rate. The [illegible] $1 per ton leaves $10 per ton as the haulage part of [illegible] 17 mills per ton mile. Less carload [illegible] to the car; on the basis of 8 tons [illegible] Boston to Chicago, pays less than 8 ct. [illegible] gravel is worth 75 ct. per ton. To [illegible] to that accruing from the transportation [illegible] Seaboard Chicago rate must be [illegible]

The same situation but to a lesser [illegible] Continental Rate Scale both east and west bound [illegible] the class rate scale applying from [illegible] including west bank Mississippi River [illegible] and Minneapolis, except as to part of Group 1. The existing C. F. A. Class Rate Scale is entirely inadequate [illegible] miles in so far as the L. C. L. classes are concerned. The increase in third class 5 miles to 205 miles [illegible] 21 ct. per [illegible] miles to 305 miles the increase [illegible] ct. per 100 lb. A one having a terminal haul of 100 [illegible] haul of 300 miles would earn but $2.14 per ton out of which must come the one terminal cost—a money losing proposition. It is not difficult to determine why railroad revenues are inadequate when such situations are allowed to continue. The First Class Rate between the Seaboard and Chicago should be at least $1 per 100 lb. to return a fair margin of profit. Many other class rate scales must be advanced to be reasonable and in line with present conditions.

Gravel is a very cheap commodity, probably the lowest priced commodity shipped. It is today worth [illegible] at point of shipment about 60 ct. per ton or $30.00 per car. Even coal, which is also a comparatively cheap commodity, is worth from six to eight times as much as gravel. Furthermore, sand or gravel cannot be damaged by transportation hazards unless it be dropped into a river. It cannot be burned, it is unaffected by weather. No liability attaches to the transportation, which can be said of no other commodity. The hauls are short which makes frequent use of the car possible. But it is a commodity that cannot stand high rates. If it moves at all, it moves on low rates, but rates that are highly profitable to the carrier. Furniture, machinery, lumber or grain, worth from $50 to $500 per ton, can move on high rates. Not so sand and gravel. Very little of it moves at more than $1 per ton. To add to the existing rates the advances proposed would mean rates in excess of $1.00 per ton for movements of less than 75 miles. Undoubtedly such advances would materially reduce road building—a prospect that cannot be contemplated with indifference.

The following is from report of the United States Geological Survey for 1918, on the Mineral Resources of the United States, page 300:

"The producers found business better during the first half of the year, but after July 1, 1918, there was a pronounced decline in the volume of business. The date of this change coincides closely with the date when freight rates were increased. General Order No. 28, of the United States Railroad Administration providing for an increase of 25 per cent went into effect June 25, 1918. The freight rates on sand and gravel were increased 1c for each 100 lbs., or 20c a ton, equal to $6 or $7 a carload. An increase of this kind might not affect products of the higher grades, but it would and did affect those of the lower grades, which sell at the lowest prices."

Your magazine reaches a large number of engineers and contractors, who for some reason have been led to believe that the movement of construction materials is not profitable business to the railroads, some even believing that the railroads handle these commodities more or less as a favor. For this reason contractors in many cases have been reluctant to insist upon their rights in the matter of freight and transportation privileges, feeling that this favor might be withdrawn.

E. GUY SUTTON,

Business Manager, National Association Sand and Gravel,
Indianapolis, Ind., Producers.

Am. Soc. Mun. Improvements Convention to Consider Pavement Repair Methods.—One of the important problems to be discussed at the convention of the American Society for Municipal Improvements, St. Louis, Oct. 12-15, will be the condition of city pavements throughout the United States following the four years of neglect during the war. It has been stated by prominent authorities that over $100,000,000 in city pavements have been ruined by the failure to keep up paving repairs during the time that all energies were devoted to war industries. The municipal engineers now face the problem of bringing these pavements back into service with the least expenditure.

Central Mixing and Proportioning Plants in National Old Trails Road Construction in Illinois

Construction operations now under way on the National Old Trails Road in Illinois by the Henry W. Horst Co., contractors, Rock Island, Ill., furnish an opportunity for comparing two methods of handling the concreting. On one section of this work the Horst Co. is using a central mixing plant and on the other section it is using a central proportioning plant. The first mentioned method is employed on Section 6, Federal Aid Project No. 9, the plant being located at Hagarstown, Ill., 12 miles distant from Section 5 of Federal Aid Project No. 9, on which the central proportioning plant is being used. Section 5 comprises 27,800 ft. of 16-ft. wide 1:2:3½ pavement. The construction of the road is under the direction of C. M. Hathaway, Engineer Illinois Division of Highways.

Central Mixing Plant at Hagarstown.

Unloading Plant.—Sand and stone are received by rail and are unloaded into stock piles by a guyed derrick having a 75-ft. mast and 60-ft. boom equipped with a 1 yd. clam shell bucket. The derrick is operated by a 3-drum steam hoisting engine and a separate slewing engine. The derrick engineer stated that he uses less than 500 lb. of coal for fuel in 10 hours when operating fairly continuously. With a fireman and a man in the car, the engineer stated he could unload a 35-40 cu. yd. flat bottom gondola in 45 to 70 minutes. From 9 to 11 50-ton cars represent 10 hours' unloading; the latter figure when conditions are favorable. On much of the work, the clam-shell bucket must be swung through almost 180° for unloading. The storage capacity for aggregates is about 125 carloads.

Concrete Mixing Plant. A 2-bag batch Austin cube paver is used for mixing concrete. The mixer is elevated on cribbing sufficiently to discharge the mixed concrete into motor trucks. Back of the mixer are two bins for sand and stone, having a capacity of about 30 cu. yd. each. The derrick keeps these bins filled either from the stock piles or direct from the cars. The bins discharge into measuring boxes so placed that they can be emptied directly into the skip of the mixer. The mixer and its skip are operated exactly as would be the case were it working directly on the subgrade, except that it is, of course, stationary and elevated, as previously described.

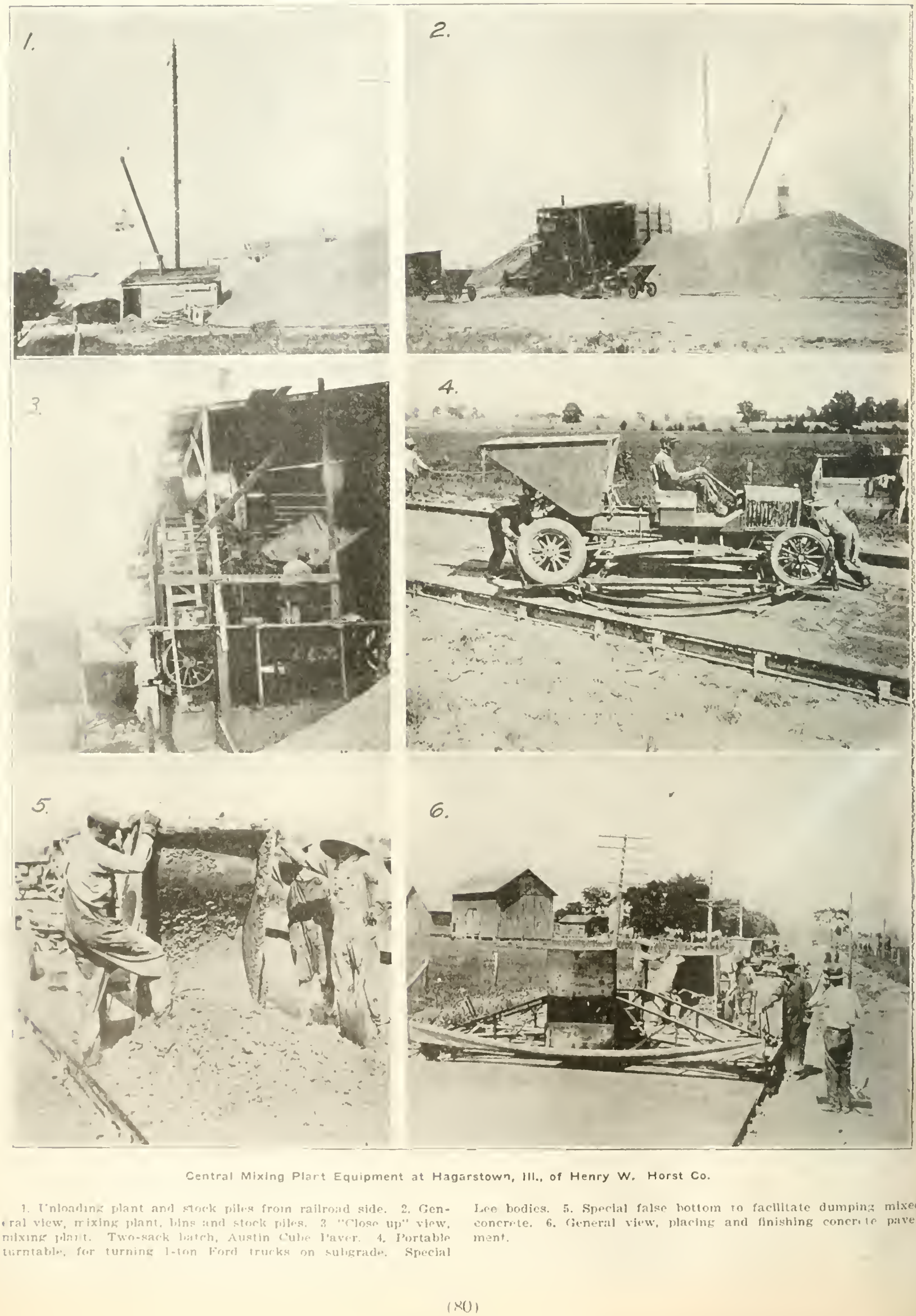
Cement in sacks is stored in a small shed along the track or in a barn nearby and is dumped into the mixer skip in the usual way. The mixture used is 1:2:3½. The drum revolves at 18 revolutions per minute.

Hauling Equipment. The contractor was hauling the mixed concrete with 12 Ford 1-ton trucks equipped with 1 cu. yd. Lee dump bodies. The rear tires of these trucks are Firestone cords 33 by 5 in. Front tires are Firestone fabric 30 by 3½ in. The rear wheels had to be equipped with special rims to take this size tires.

Two 2-bag batches of concrete are hauled at a load, giving about 17 cu. ft. of mixed concrete. One of the bodies had been fitted with a false bottom of light sheet metal, bolted and hinged to the top edge so that when the body was dumped, this false bottom swung out, eliminating any trouble from sticking in the bottom of the receptacle. The contractor plans to equip all of the truck bodies with these false bottoms.

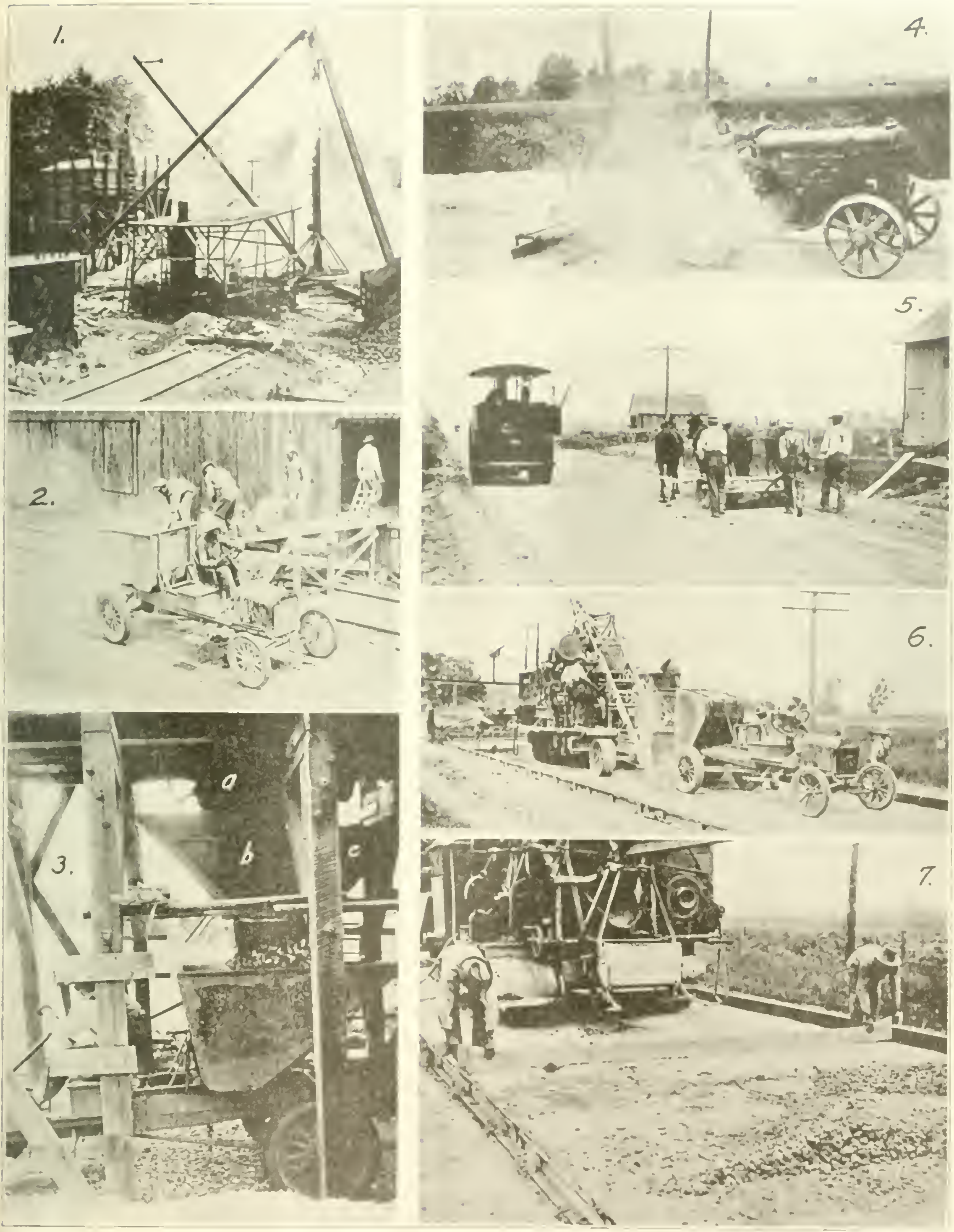
The day's record for this outfit this year was 419 lin. ft. of 16-ft. pavement in 9½ hours, with 8 trucks hauling concrete slightly over 1½ miles. The pavement averaged 7⅔ in. in thickness; therefore, this run would require a volume of 170 cu. yd. of concrete, or 550 batches, or 275 truck loads. This would be the equivalent of 62.2 seconds per batch for mixing and emptying from the drum. With 8 trucks hauling, this record means a load every 16.6 minutes, or an average speed of 10.7 miles per hour, including all stops. Subtracting the idle time for the trucks loading, turning and unloading, the actual running time would be about 12 minutes per round trip, or an average speed of 15 miles per hour.

Placing and Finishing.—Three men dumped the Lee bodies and did what little hand spreading of the concrete was neces-



Central Mixing Plant Equipment at Hagarstown, Ill., of Henry W. Horst Co.

1. Unloading plant and stock piles from railroad side. 2. General view, mixing plant, bins and stock piles. 3. "Close up" view, mixing plant. Two-sack batch, Austin Cube Paver. 4. Portable turntable, for turning 1-ton Ford trucks on subgrade. Special Lee bodies. 5. Special false bottom to facilitate dumping mixed concrete. 6. General view, placing and finishing concrete pavement.



Central Proportioning Plant Equipment at Brownstown, Ill., of Henry W. Horst Co.

1. Unloading plant, stock piles, and loading line from railroad side. 2. Loading cement for batch from [illegible] warehouse used as storage space. 3. Dumping sand and stone for batch into Lee body. (a) Radial gate controlling flow of stone from bin above. (b) Measuring box for stone. (c) Measuring box for sand. 4. Fordson tractor with drag smoothing up subgrade. 5. Western fresno scraper and Springfield steam roller. 6. Delivering dry batch to mixer. One cu. yard Lee dump body on 1-ton Ford truck. 21-E Austin Cube Paver with gasoline engine. Lakewood finishing machine. Blaw Knox type B steel forms. 7. Checking subgrade. With No. 6 this view also illustrates finishing operations and consistency of concrete.

sary A Lakewood tamping machine took care of the finishing operations. Blaw-Knox steel side forms were used.

Truck Turntable.—A portable turntable was used on the subgrade, about 75 to 100 ft. in advance of the point where the trucks dumped their loads of mixed concrete, for the purpose of turning the trucks without cutting up the subgrade. The turntable was designed by the contractor's engineers, and specially built. It rests on two 3 by 12-in. planks shod with iron strips on the bottom, which serve as skids. These planks are parallel to the center line of the highway. The planks support a 10-ft diameter circular track made up a 4-in. "I" beam. Two 8-in steel channels 13 ft. in length are framed together with 3 by 3-in. angle irons and steel gusset plates and form a track for the truck wheels to stand on while being turned. These 8-in channels are each bolted to two small carriages built up of 3 by 3-in. steel angles with two wheels to the carriage. The wheels have a 4-in. face between the flanges, are 3 in in diameter for the bearing surface and 6 in diameter for the flanges, and ride on a 1-in. axle. The 8-in. channels which carried the trucks were somewhat too light for the purpose and one of them was slightly bent so as to make the turntable hard to operate. A heavier channel would have avoided this.

The turntable is dragged ahead either by a team or by a Fordson tractor, which is part of the grading equipment. The table was too heavy for the Ford trucks to drag ahead.

Grading Equipment.—The contractor used teams and slip scrapers for grading, together with a light tractor for pulling a rooter plow and steel drag for finishing. There was also a 13-ton, 3-wheel gasoline roller made by the Austin Manufacturing Co.

Organization of Concrete Crew.—The organization of the concrete crew was as follows:

Unloading plant—Derrick engineer, fireman and man in car....	3
Handling cement—Man loading truck, driver hauling cement to mixer	2
Loading mixer skip—Two men handling cement, one man handling aggregate	3
Mixing concrete—Engineer, fireman, skip operator.	3
Hauling concrete—9 truck drivers	9
Turntable	2
Dumping and spreading concrete	3
Finishing—Machine operator and hand finisher	2
Curing concrete—2 men sprinkling and covering	2
Setting forms	2
Water supply—Pump operator	1
Blacksmith	1
Fine Grading—1 team and 6 men	6
Total	39

Central Proportioning Plant.

Unloading Plant.—All materials are received by rail. Cement is unloaded into a storage shed, the capacity of which is about four cars, or into other sheds and barns in the vicinity rented for the purpose. Space is available for a total storage of about 25 carloads.

Sand and crushed stone are unloaded with a stiff-leg derrick which has a 60-ft. boom and 50-ft. mast. With a 1-yd. clam shell bucket the derrick can unload 10 50-ton cars in a day, according to the superintendent, which is probably as rapidly as the aggregates can be used. Storage capacity for aggregate is about 100 carloads. Derrick can unload no more than two cars without spotting.

Proportioning Plant.—One-yard Lee dump bodies mounted on 1 ton Ford trucks are used for hauling dry batches to the mixer on the subgrade. The driver first stops at the cement shed where four sacks of cement are emptied into the Lee body. He then proceeds to the aggregate loading bins where he drives under two adjoining measuring boxes. The flow of sand and stone into these boxes is controlled by steel radial gates. The operator has previously filled each box so that as soon as the truck is in position he releases a lever which allow doors on the bottom of the boxes to drop, discharging both sand and stone at the same time. Each driver calls out his truck number as he leaves with a load, and the operator at the loading bins keeps track of the number of trips made.

Hauling Equipment.—With a haul of approximately 1½ miles, 13 trucks were in use. Hauling this distance, a driver was expected to average three trips an hour. Nineteen trips in five hours was the record made by one man, but only 13 or 14 trips were made on the following day in a similar period of time. As the trucks are new they are not running very smoothly. A mechanic spends most of his time looking after the trucks and automobiles on the job, and a stock of extra parts is kept on hand so that repairs can be made without delay. Drivers are instructed not to exceed 12 miles an hour with a load, or 15 miles empty, but it is difficult to keep them within these limits; not all of the trucks are equipped with speedometers. Rear tires are 33 in. by 5 in.; front tires 30 in. by 3½ in.

With the present equipment 39 batches an hour would be delivered to the mixer if the trucks maintained the standard of three trips per hour on the 1½-mile haul. With 40 batches an hour, the mixer would turn out concrete for about 700 lin. ft. of pavement in 10 hours, which the superintendent says is a good average.

Turntable.—The track turntable used on this job was exactly the same as that at Hagarstown except that a sheet metal housing had been added to protect each roller. One man could swing the turntable readily. The I-beam was well oiled and the end of the channel-track nearer the mixer was kept slightly lower than the opposite end so that the weight of the load helped swing the turntable around.

Mixing and Placing.—Concrete is mixed in a 21-E Austin Cube Paver, mounted on wide front wheels and caterpillars in the rear, and operated by a 40-HP. gasoline engine which consumes about 35 gal. of gasoline in 10 hours.

A strip of sheet metal has been riveted to the bottom of the skip, extending out far enough so that trucks can dump without backing up so close that the ends of the Lee bodies would catch on the skip. The mixer is equipped with a boom and a bottom dump bucket. The bucket holds the entire batch. Two men who continuously work at fine grading check the subgrade frequently, using a 1-in. by 6-in. board having nails driven in its bottom edge so that they project 1 in. Triangular pieces fastened to the board near each end support it on the side forms.

Mixing water was measured by a device on which a pin is set in a quadrant according to the number of gallons required for the batch. A lever presses against this pin, and when the lever is released, it slowly travels to a fixed stop. As the rate of travel depends upon the revolutions per minute of the mixer drum the speed must remain constant or the pin must be reset. Water flows into the mixer drum while the lever is moving, coming from a small, constant pressure tank.

Finishing and Curing.—With a Lakewood tamping machine and one man finishing by hand, good results were obtained. Concrete was sprinkled soon after it was placed and later part of it was covered with canvas. Enough men were put on the job to place a 2 to 4-in. layer of earth on the pavement when it had hardened sufficiently. Blaw-Knox Special Road Forms, Type B, were in use.

Water was pumped about one mile through a 2-in. pipe line by a C. H. & E. triplex pump operated by gasoline engine. No extra engine nor pump was on the job.

Grading Equipment.—Two tractors were on the job—one a Fordson, used for pulling a small road drag and occasionally a plow, and the other an Avery which pulls a blade grader. The roller was a 9-ton 3-wheel steam Springfield. For moving earth up to 200 or 300 ft., a Fresno ½-yd. scraper was proving very satisfactory. It was doing as much work as 4 slip-scrapers, according to the superintendent, and required only three men and two teams to operate it.

Organization of Concrete Crew.—The organization of the concreting gang was as follows:

Unloading plant—Derrick engineer, fireman and man in car..	3
Loading batches—2 men trucking cement and 2 men emptying bags; 1 man handling aggregates	5
Hauling batches—13 truck drivers, 1 mechanic	14
Setting forms—2 form setters and 1 helper	3
Turntable	1
Mixing concrete—Engineer, skip operator	2
Placing concrete	3
Finishing—Machine operator, hand finisher	2
Curing concrete	6
Water supply—Pump operator	1
Fine grading	2
Total in crew, exclusive of foreman and men unloading cement from cars	42

Cost of Street Oiling at St. Paul.—During the season of 1919 some 164 miles of streets of St. Paul, Minn., were treated with oil. The Auto oiler distributed 10,000 gal. of tarvia and 582,113 gal. of road oil at a cost of $4.83 per 1,000 gal.; this cost includes the chauffeurs, operators, gasoline, oil and upkeep. In 1918, oil cost 8.6 ct. per gallon, and in 1919 6.5 ct. per gal. This is a decrease of 24 per cent. In 1918, the cost of oil was 77 per cent of the total cost of oiling—in 1919 it was 62 per cent of the total cost.

Methods and Costs of Cement Tile Sidewalk Construction at St. Paul, Minn.

By E. G. BRIGGS,
Consulting Engineer St. Paul; Formerly City Sidewalk Engineer

The constructing, relaying and repairing of cement sidewalks in the city of St. Paul has for several years been done by contract, the work being let by the City Council to the lowest responsible bidder. The specifications under which the walks were constructed relaid or repaired were compiled by the Bureau of Engineers, Department of Public Works, and a contract was let for all work ordered by the City Council, through petition to that body or instigated on an order of public necessity by the Council, between the months of November of each succeeding year.

The contractor was allowed until July 1 of the year following the expiration of his contract in which to complete the work. The supervision and construction of all the work has been under the direct charge of a sidewalk engineer, directly responsible to the chief engineer of the city. All work executed in the field has been under the direction of an inspector and has been constructed on lines and grades given by the engineering department, all under the direction of the sidewalk engineer. The volume of work executed through the City Department increased approximately 100 per cent during the 4-year period prior to the world war, when in 1917 the total cost of sidewalk work executed by the contractor amounted to approximately $100,000.

It became quite apparent at this period that the volume of construction had become of sufficient size to allow a division of the work, thus giving the smaller contractor equipped for competing on quality of work but not on the volume of work, a chance to bid on portions of the contract, the idea being to attract competitive bidding and thus develop a benefit to the property owners affected. In the spring of 1918 the division of the work was planned and contracts let accordingly.

In considering the cost of the construction, relaying and repairing of cement sidewalks in the city of St. Paul during the past four years it will be necessary to give a few paragraphs of the specifications for the construction in that the reader may have a fair conception as to the exact conditions under which the work has been executed and a comparison can be made with methods executed in other cities. Approximately 98 per cent of all walks constructed are of the pre-cast tile method. These tile are constructed under careful city inspection at the shop of the successful bidder, generally during the winter months and made in sizes, 2 ft. square or 4 sq. ft. and 1½ ft. square or 2.25 sq. ft., thus allowing three squares of one for a 6-ft. walk, designated as a standard width of three squares of the other for a 4.5-ft. walk, which is often approved for narrow streets or where walks are less frequently used.

Provision is made in the contract for the construction of monolithic concrete walks, but a very small per cent of this construction is executed as it is more expensive, offers considerable disadvantage in repairing and it has been found that it is not as satisfactory in this latitude as the tile construction, which affords the many joints and opportunities for heaving, expansion or contraction and general climatic readjustments. However, it is not a fast rule and wherever property owners require the monolithic construction it has been given.

All tile used are constructed in molds of the proper dimensions substantially built, free from warp and having all angles, right angles. The titles are 2 in. thick, the lower three-fourths is composed of 1 part Portland cement and 4 parts of clean, sharp sand, thoroughly mixed and carefully rammed into the molds to a uniform depth. The upper one-fourth is composed of 1 part portland cement and 2 parts of clean, sharp sand, placed immediately upon the lower part and thoroughly rammed to the proper thickness. Extracts from the specifications follow:

The surface shall be [illegible] shall be kept wet for [illegible]. [illegible] shall be [illegible] on the work unless at [illegible]. In [illegible] the walk in the field the contractor [illegible] stumps and other material from the [illegible] where the sidewalks are to be laid. The contractor shall [illegible] as may be necessary to bring the foundation to the [illegible] in. below the established grade [illegible].

In calculating the cost of the construction [illegible] per square foot includes the [illegible] excavation [illegible] 8 in. in depth provided for the [illegible]. The foundation [illegible] consolidated by wetting [illegible] or [illegible] of proper stability soft and spongy places must be dug out and refilled with [illegible]. Upon the foundation thus prepared there shall be first laid 4 in. of broken stone, brick, coarse gravel [illegible] or cinders which shall be rammed or rolled, then [illegible] with coarse sand or gravel free from sand and rammed or rolled to a smooth surface. On this first coat shall be laid [illegible] in. of mortar composed of 5 measures of clean, sharp sand and 1 measure of Portland cement. The sand and cement may be mixed in dry state by turning over with shovels at least four times, when sufficient water shall then be added to make a stiff mortar and again turned until a uniform mixture is obtained. It shall then be rammed in place with a proper rammer to get a smooth and uniform surface. Upon the foundation thus prepared shall be laid square or hexagonal blocks or tile 2 in. thick measuring 18 in. or 24 in. between the parallel sides. All blocks shall be laid so as to present a true surface on top and conform to the exact grade of the sidewalk. A thin grouting of neat Portland cement shall be spread over the surface and carefully swept into the joints. All superfluous grouting shall be cleaned off and unless otherwise ordered the edge of the sidewalk shall be finished with a plastering of Portland cement and sand in the proportion of 1 to 2, in which case the foundation shall be made 3 in. wider on each side than the walk.

Basing the cost of the manufacture of tile on the operations involving an output of 280,000 sq. ft. as an average yearly output during the seasons of 1916-17-18, the following table of actual costs develops.

In the manufacture of the tile according to the specifications as stated, it has been found that 1 bbl. of cement will average 80 sq. ft. of tile, one bag averaging 20 sq. ft. or five 2 ft. x 2-ft. tile.

	COST		
Material.	Per bbl.	Cu. ft.	Sq. ft. tile
Cement	$1.90	$0.475	$0.0237
Sand	Cu. yd. $0.50	0.0185	.0030
Total cost per square foot for material......			$0.0267

The sand used has been screened, not washed and by analysis contains voids equal approximately to the quantity of cement specified.

The sand required for the tile 2 ft. by 2 ft. in dimensions totals .66 cu. ft. or .165 cu. ft. of sand per square foot of tile.

The labor for the manufacture of tile is based on the average operation covering the period of constant operation of the factory from about Dec. 1 to April 1 of each year, or that portion of the year in which no outside construction can be executed.

The sand has been conveyed by means of a belt conveyor, power furnished by an electric motor, from the pit directly to the hoppers above the mixing platform, where it is mechanically screened ready for use. Two laborers are occupied in the pit, two men at the mixer, four tile makers and two laborers carry cured tile to yard and stack green ones on drying racks. These with one foreman overseeing the general operations, ordinarily constitute the total labor.

The hours worked has averaged nine, but the result of the finished product has had considerable bearing on the hours worked. It has been found by operations covering numerous tests and experiments that good and satisfactory results can be obtained best by careful workmanship, that poor workmanship will make the ideal mixture of little value and standard results cannot be obtained. It has therefore been the custom to limit the tile makers to the manufacture of 100 sq. ft. per day and this process to cover an 8-hour working period. It has been found that this method of manufacture assures the proper tamping and finishing of each tile in a manner to produce the proper strength, wearing surface and general appearance.

During the curing of the tile it is necessary to keep the molds warm and the temperature and humidity of the curing house proper for best curing results, consequently the necessary heating and drying system must be provided, and it is calculated the necessary fuel, and labor for supplying same, current for mixer motors, general superintendence, plant depreciation and incidental overhead, amounts to approximately ½c per square foot

LABOR COST INCLUDING CURING AND OVERHEAD.

Item.	No.	[illegible]	Cost per day.
Foreman	1		$ 5.00
Tile makers	4	[illegible]	12.00
Mixers	2		5.00
Laborers	4		9.00
Curing, superintendence, overhead depreciation			9.00
			$40.00

Total cost per square foot for labor, curing and overhead, $0.0250.

The total cost of tile per square foot on racks in yard is therefore:

Material	$0.0267
Labor including curing and overhead	.0250
Total	$0.0517

For the actual construction of sidewalk the following calculation is obtained. The tile are generally delivered on the street with a 5-ton motor truck averaging four truck loads per day. This has been found to be the most economical method of delivery. The average load consists of 320 sq. ft., weighing approximately 7,000 lbs. The laborers in the yard at the factory with the assistance of the driver, load the truck and the driver is assisted by the sidewalk crew in unloading the tile at their destination. It will be noted than an average of 1,280 sq. ft. of tile are delivered on the street during the 8-hour day. The cost has averaged approximately 1 ct. per square foot of tile for this delivery.

The construction of the walk as calculated on the average of construction for the period in consideration shows that four men and one foreman average 100 ft. of 6 ft. walk per 8-hour day.

Cinders for the base have been obtained free at the gas plants and other places where considerable coal is consumed. The cinders have been delivered at the site of the construction in 3-yd. dump wagons and an average of four loads per day have been received. Sand for the concrete between the cinder base and the tile has generally been obtained near the place of construction. A team with driver is required part time with each crew to plow and assist in preparing the base, remove the surplus material, haul sand and move forward water tanks and form material incidental to the construction. For the total field operations to complete the walk, the following table gives an average of the costs involved:

AVERAGE CONSTRUCTION COST.

Item	No.	Total cost.	Total sq. ft.	Cost per sq. ft.
Delivering tile	1280 sq. ft.	$12.80	1280	$0.0100
Cinders	12 cu. yd.	6.00	960	.0062
Concrete sand—Included in price of team.				
Cement	3.75 bbl.	7.12	600	.0118
Laborers	4	9.00	600	.0150
Foreman	1	5.00	600	.0083
Team	1 ½ time	3.00	600	.0050

Total cost per square foot for construction.............$0.0563

For a tile constructed sidewalk, according to the specifications, we have a total estimated cost for the completed work as follows:

Cost of tile in stock at yard per square foot	$0.0517
Cost of delivering tile, cinders and constructing walk, per square foot	0.0563
Total cost per square foot	$0.1080

Table 1 gives the contract prices covering operations for the past four years on sidewalk work and incidentals connected with the construction from which considerable additional revenue has been received.

TABLE 1. CONTRACT PRICES FOR SIDEWALK CONSTRUCTION AND EXTRAS, 1916 TO 1919, ST. PAUL.

Item	1916	1917	1918 Dist.1	1918 Dist.2	1919 Dist.1	1919 Dist.2
Cement tile walk, per sq. ft.	$0.[illegible]	$0.108	$0.105	$0.12	$0.0975	$0.105
Cement [illegible] per lin. ft.	[illegible]	0.06	0.05	0.07	0.05	0.06
Removing [illegible]	[illegible]	0.05	0.05	0.10	0.05	0.10
[illegible]	1.25	1.50	1.[illegible]	1.50	4.50	4.75
Portland cement concrete	[illegible]	6.00	4.50	7.00	5.00	6.50
Brickwork, per [illegible]	17.[illegible]	15.00	11.00	15.00	16.50	....
Earthwork, per cu. yd.	[illegible]	[illegible]	0.60	0.70	0.75	0.75
Lumber, per [illegible] ft. B. M.	[illegible]	[illegible]	40.00	50.00	40.00	40.00
Reinforcing iron [illegible] per lb.	[illegible]	[illegible]	0.11	0.12	0.10	0.12
Brick paving [illegible] concrete foundation	[illegible]	[illegible]	2.[illegible]	2.75	2.60	2.75
Reinforced concrete [illegible] thick, per sq. ft., reinforcing steel extra	[illegible]	0.[illegible]	[illegible]	0.40	0.25	0.40
6-in. sewer pipe in place, per lin. ft.	[illegible]	[illegible]	[illegible]	[illegible]	0.55	0.55
12-in. sewer pipe in place, per lin. ft.	[illegible]	[illegible]	[illegible]	[illegible]	0.70	0.70
15-in. sewer pipe in place, per lin. ft.	[illegible]	[illegible]	[illegible]	[illegible]	0.80	0.80
Cement walk surfaced in place	[illegible]	[illegible]	[illegible]	0.20	0.15	0.20

The contracts for 1916, 1917 and district No. 2 in 1918 were executed by one contractor.

The Fourth International Road Congress and Membership in the Permanent International Association of Road Congresses

By ARTHUR H. BLANCHARD,
Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich.

The First International Road Congress was held in Paris in 1908. At this Congress, the Permanent International Association of Road Congresses was formed with headquarters in Paris. The Second Congress was held in Brussels in 1910.

The Third International Road Congress was held in London in 1913, at which time there were 3,793 members of the association. The business sessions of the Congress occupied about one week and were devoted to a thorough discussion of the subject matter of 123 reports pertaining to the 19 topics on the program of the Congress. During the final business session, progressive conclusions relative to each topic were adopted by the Congress. The Government of the United States was the only world power which was not a member of the association when the Third Congress was held. The records of the Third Congress indicate that the following important countries were members of the association: Austria, Belgium, France, Germany, Great Britain, Italy, Japan, Norway, Portugal, Russia, Spain, Sweden and Switzerland. Of the smaller countries, it is interesting to note that our neighbors, Cuba and Mexico, sent Government delegates to the London Congress and are Government members of the association.

The International Commission of the Permanent International Association of Road Congresses, at its meeting held in Paris on June 21, 1920, unanimously voted to accept an invitation to hold the Fourth International Road Congress in the United States in 1922 provided an invitation from the United States Government is received by the Executive Committee of the association before Jan. 1, 1921. If an invitation is not received from the United States on or before Dec. 31, 1920, the invitation from the Italian Government will be accepted. As a regulation of the association stipulates that an international congress cannot be held in a country whose Government is not a permanent member of the association, it will be necessary for the United States Congress, during November or December, 1920, to pass an appropriation which will provide for the annual subsidy of the United States as a Government member of the association and which will enable the Secretary of State to extend an official invitation to the association to hold the Fourth International Road Congress in the United States in 1922.

The object of the association is to promote progress in the improvement of highways and the efficiency of highway transport throughout the world. The work of the association consists in organizing international road congresses, publishing reports, papers, proceedings and other documents and collecting information relative to highway improvement and highway transportation.

The membership of the association consists of representatives of governments, delegates of corporations and individual or private members. The business affairs of the association are managed by the Permanent International Commission which is composed of members representing the various Governments having membership in the association. Each Government has the right to one representative for each 1,000 francs of its total annual subsidy, provided, however, that the number of representatives from any one Government does not exceed fifteen.

Individual or private members pay annual dues of 10 francs or compound for a life subscription by the payment of one sum of 125 francs. Due to the current rate of foreign exchange, it is practicable for Americans to become life members by the payment of the subscription of 125 francs through the medium of a bank draft, which will cost, at the present time, between $9.50 and $10. Life membership dues should not be sent by an international postal money order, as an order for 125 francs will cost approximately $25. Bank drafts should be made payable to the permanent International Association of Road Congresses and be sent to Professor Paul LeGavrian, General Secretary, Permanent International Association of Road Congresses, 1 Avenue d'Iena, Paris, France.

Individual members receive, free of charge, all of the publications of the association, including papers, reports and proceedings of congresses which, in times of peace, are held triennially. The reports and proceedings of the Third International Road Congress, measure, when stacked, about $6\frac{1}{2}$ in. by $9\frac{1}{2}$ in. by 8 in. in height. The reports contain reliable information pertaining to the progress in highway development and highway transportation in all important countries and hence serve as an encyclopedia of foreign practice. Members also receive the Bulletin of the association, each issue consisting of 40 to 50 pages devoted to official notices, minutes of meetings of the International Commission and the Executive Committee, and reviews relative to highway improvement and highway transport in different countries. All the literature, sent to American members, is printed in English.

The International Association should be supported by Americans, who wish to see the science and art of highway improvement and highway transport rapidly develop throughout the world, who believe in an international medium for the exchange of opinions and conclusions, and who wish to be well informed relative to progress in highway engineering and transportation in foreign countries. Americans should not be satisfied with joining the association as individual members. Although every courtesy was extended to the United States members of the association at Paris, Brussels and London, nevertheless every American who has attended an International Road Congress has wished to apologize because his Government was not a permanent member of the association. Considering the phenomenal development of highway improvement and highway transport in the United States, and the active part which the United States Government is taking in highway construction through the medium of the Federal-Aid Act, it requires no elaborate arguments to demonstrate the advisability of the United States Government becoming a permanent member of the association. The status of the United States as a leading world power demands that its annual subsidy should be the maximum allowed by the constitution of the association; that is, 15,000 francs, which will provide for 15 representatives of the United States on the Permanent International Commission. It is the duty of every American, who wishes to support the work of the International Association and to have an International Road Congress held in the United States in 1922 to write to his representatives in Congress urging them to vote favorably on an appropriation to provide for the annual subsidy of the United States as a Government member of the Permanent International Association of Road Congresses.

Per Capita Expenditures Upon Roads. Figures compiled by the Commission Club of Salt Lake City give an interesting comparison of per capita expenditures for roads in states west of the Mississippi. The figures are based on the records of the Federal Government for total expenditures during the first 10 months of 1919 and funds still available for work this year and next year with the per capita based upon the 1910 census. The list follows:

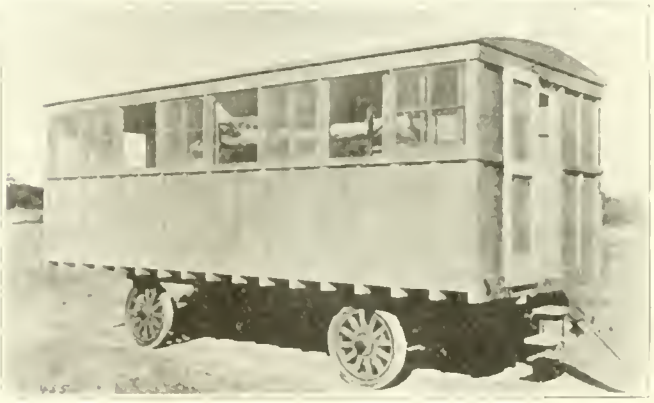
Utah	$27.03
Montana	16.75
Texas	15.52
Oregon	11.87
Iowa	8.69
California	8.41
Idaho	6.41
Colorado	5.93
Washington	5.69
Minnesota	5.36

Cost of Tree Planting at St. Paul, Minn.—Tree planting in the streets of St. Paul is handled by the Department of Public Works like any other public improvement, and is paid for by an assessment against the property benefited. The cost during the past season, according to an article by J. E. Carroll, Superintendent Bureau of Construction, in the September Bulletin of the Affiliated Engineering Societies of Minnesota, ranged from 10 to 15 ct. per frontage foot for trees 10 ft. to 12 ft. high of 2 in. to $2\frac{1}{2}$ in. in diameter. These figures include all labor and the necessary black loam in setting the trees. The trees are set [illegible] 40 ft. apart in the center of the boulevard and [illegible] part [illegible]. In 1919 the trees cost about $1.10 each; this year the city is paying up to $1.25. Black loam costs from $2 to $3 per cubic yard, depending on the length of haul. In estimating the cost of doing this work it is figured that one man in 8 hours should dig at least 40 holes and [illegible] men should plant 20 trees in an 8-hour day.

Trailer Camp Train for Housing Construction Gangs

The Pacific Telephone & Telegraph Co. of California is housing its line construction crews in trailer camp trains. The company has taken delivery of 17 special truck trailers built to its order by a Los Angeles trailer manufacturing company for use in road trains as living quarters for crews of 35 to 40 men, and is expected to receive 10 or 15 more such trailers in the near future. It is now operating between 40 and 50 trailers of the same make for various hauling purposes.

Each work train is composed of five trailers and is drawn by a motor truck from place to place as line construction progresses or as crews are shifted from one line to another. Upon arriving at destination, the truck is detached and used for hauling materials, etc., used on the job.



Combination Office and Sleeping Car.

The make-up of each train includes two sleeping cars, a combination sleeping car and office for engineers and foreman, a combination dining and cooking car and a water-tank and tool car. All are built on 2-ton trailer chassis and, with the exception of the tank and tool car, have railroad type bodies 8 ft. wide, with sliding windows along the sides. Windows and doors are screened against insects and there are ventilators in the roof.

The trailers vary in length, the sleeping cars being 25 ft. long, the dining cars 20 ft. and the water tank car 13 ft. The combination office and sleeping car illustrated herewith is typical of the appearance of all the closed trailers except that the sleeping cars for the workmen have center side doors and steps. One end of the trailer shown is partitioned off for use as an office, while the other end, like the sleeping cars, has full-sized, individual berths and a wash room with shower baths, etc.

The dining cars are similarly partitioned, one section having a U shaped counter surrounded by stools for 14 men and the other being equipped with a large range, a large sink with hot and cold running water, an ice chest, a dish closet and bins for storage of flour, sugar and vegetables.

Considerable thought was given to the water and tool car, as much of the line construction work of the telephone company is carried on in arid regions. A cylindrical wooden tank of 400 gal. capacity is placed longitudinally, with tool boxes along either side easily accessible by men standing on the ground. A centrifugal pump with attachment for a hose is mounted on one end of the trailer platform, making the filling of tanks in the sleeping and cooking cars quick and convenient.

The comfortable, convenient and sanitary accommodations provided by these work trains for use on the highways is expected to insure a more contented lot of workmen on jobs that take them away from populated centers for more or less protracted periods.

Contract Work vs. Municipal Forces in Street Cleaning

A study of the method employed by various municipalities in street cleaning and in the collection and disposal of municipal waste has been made recently by E. B. Morden, Chief Bureau of Street Cleaning, J. W. Follin, Engineer, Bureau of Municipal Research, and J. H. Neeson Assistant Engineer, Bureau of Highways, of Philadelphia. The results of this investigation were given in a report submitted last July to the City Council of Philadelphia.

The cities visited were New York, Chicago, Detroit, St. Louis, Pittsburgh, Toronto, Canada; Buffalo, Washington, D. C.; Newark, Baltimore, Rochester, N. Y.; Columbus, O.; Worcester, Mass.; New Bedford, Mass., and Trenton, N. J. It was found that in each of these cities the street cleaning work proper was done directly by municipal forces; that ashes and rubbish were collected by municipal forces in all the above cities except Pittsburgh, and that municipal forces collect garbage in all these cities, except Pittsburgh and New Bedford, Mass.

The committee found that street cleaning work in a number of cities was being reduced due to the rapidity of motorization of all vehicles, this observation applying particularly to Detroit, Mich., where the absence of horses is quite noticeable, and in consequence of which there is less street dirt than formerly. It also was noted that several cities, in particular Detroit, Mich., were endeavoring to partly or completely motorizo their street cleaning and collection services In a number of cases experiments were being conducted in the use of mechanical pick-up sweepers and other labor-saving devices for the cleaning of streets, but this is only being done to any great extent in localities where adverse labor conditions are forcing this expediency. Opinions vary as to the best methods of street cleaning and local conditions in the final analysis must determine this issue.

The frequency of street cleaning work and of refuse collection had apparently decreased in a large number of cities due to the fact that the appropriations have not been increased in direct proportion to the high cost of labor and materials.

The following conclusions are given in the report: Street cleaning and the collection of municipal refuse are matters of public service of such a character as to be poorly adapted to contract performance. The statements of municipal officials in other cities corroborate this point. Direct control of the work must be in the hands of the municipality if the required service is to be given. While the universal practice of street cleaning by municipal forces in all other large American cities would seem to be convincing proof that municipal work is more advantageous than contract performance there are many persons in Philadelphia who do not place much importance in the experienc of other cities, and it is therefore advisable to compare the two methods of performance from the viewpoint of our experience with contract work

It is perfectly clear that no contract is on a sound basis unless, (1) the work to be performed is definitely specified so that the bidder can determine the cost of performance and bid intelligently, and (2) unless it is possible for the party paying for the work to determine if the work specified has been performed. With this statement in mind let us analyze the existing contracts in Philadelphia.

Analysis of Philadelphia Contracts. The existing contract for street cleaning is disadvantageous for the following reasons:

1. It is humanly impossible completely and definitely to specify the work to be performed, for although the frequency of cleaning can be given, standards of cleanliness are not possible of definition, and the results of the street cleaning must be judged without definite specifications, and therefore,

2 It is necessary for the bidder to pad the contract price to provide against possible unfriendly attitude on the part of the bureau chief who is the judge of the work performed, and of other officials

3. The contractor is sometimes forced by unfavorable circumstances to attempt to control the city inspection force, and there is an ever present temptation to influence their reports for a consideration.

4. Undue authority is given to the bureau chief to judge the results of the work performed, and he is in a position either to make or to break the contractor as he wills.

5. It is difficult to determine whether the streets are properly cleaned because of the intangible results, and the fact that the streets do not stay clean very long after the cleaners have been over them.

6. It is difficult to obtain practical and dependable inspectors.

7. The city is unwilling to pay salaries to the street cleaning inspectors commensurate with the responsibilities involved in work of such an intangible nature, thereby putting a premium upon inefficiency and dishonesty.

8. It is impossible to guarantee to the contractor that the public as a whole will obey existing ordinances, thereby throwing the burden of their disobedience on the contractor, who has this indeterminate factor to take into consideration in making his bid.

9. The contractor is tempted to slight the work by racing his equipment and speeding up his gangs, thereby covering the streets with the specified frequency but only imperfectly.

10. It is impossible to obtain flexibility under any form of specifications to permit extensive modifications of performance such as are required by seasonable variations, or emergency shifting of forces from one district to another.

11. It is necessary for the bidder either to amortize his plant and equipment during the life of the contract, thus adding an excessive amount to the bid, or to insure by some other means that the contract will be renewed and new competition discouraged.

12. It is necessary for the contractor to add a high contingent cost to his bid to cover the greatest conceivable advances in the labor and material markets.

13. The cost is increased by dual supervision by contractor and the city.

Advantages and Disadvantages of Municipal Operation of Street Cleaning Work.—Municipal operation of street cleaning work overcomes the majority of the objections to the existing contract performance listed above, but naturally has certain inherent disadvantages of its own. The advantages of municipal operation are as follows:

1. Flexibility of organization, with ability to concentrate the force in emergencies and to revise mehods and schedules to meet changing conditions that cannot be foreseen when contracts are let.

2. The placing of the city bureau organization on a business-like basis, actually performing the work, and abolishing the rewardless task of attempting to keep the contractor's work under control.

3. The substitution for the underpaid and unsatisfactory city street cleaning inspection force of superintendents and foremen who actually direct the work and can get results, with actual economy from the abolition of costly dual inspection essential to contract work.

4. Actual saving of money to the city by eliminating the contingent fund included by the contractor in the bid price to guarantee against unfriendly or unreasonable action by the bureau chief in enforcing the specifications.

5. Actual saving of money to the city in carrying its own insurance against advances in the labor and material markets for which the bidder may make more than the necessary provision.

6. Accomplishment of the maximum possible amount of work for the money appropriated by council, since municipal work is at cost.

7. Avoidance of non-equitable contracts and possible expensive controversies in the courts.

8. Possible securing of better co-operation from the public in their care of the highways because of the sympathetic attitude of the public toward municipal work.

9. Opportunity for continuous study of conditions and for making beneficial changes in equipment and methods.

10. Direct and absolute control of the working forces

Municipal operation is subject to certain disadvantages which can be successfully overcome:

1. The present inability to obtain experienced and properly qualified employes with dispatch through the Civil Service Commission.

2. The possible failure of the proper authorities to appreciate the need of sufficient funds to carry on the work and maintain the equipment, which might cause the service rendered to the public to be unsatisfactory.

3. Possible decreased efficiency of the labor because the

foremen supervisors are not actuated by the incentive to increased profits which exist in contract performance

Advantages and Disadvantages of Contract Work. Contract work has certain inherent advantages

1 The contractor is able to purchase equipment and materials directly on the basis of practical judgment and without the competitive bidding in force in the city, thus saving delays and securing the most desirable equipment and materials.

2 The contractor is able to compensate supervising employes properly and to increase their salaries immediately to keep them from accepting more lucrative positions, and besides can offer them special inducements

3. The contractor can regulate wages and salaries without the complicated procedure required in municipal work

4. The contractor can hire and discharge employes without restriction or regulation such as Civil Service control.

In the case of street cleaning work the disadvantages of contract performance are so numerous and so overwhelming that the argument of possible increased labor efficiency under contract work is relatively unimportant Municipal operation is the only proper method and every effort must be made to overcome any disadvantages inherent to it Civil Service control should be reasonable and not arbitrary, the city purchasing agent should co-operate to secure the most desirable equipment and materials and not merely the cheapest in price; and the salaries of supervisors and foremen must be fixed equal to those prevalent in outside employment.

Concrete Paving on Adobe Sub Grade

Perhaps the most troublesome subgrade over which permanent pavements are built is the adobe found in many parts of the southwest. In the summer this soil bakes hard and cracks, leaving openings large enough to insert a man's arm Moisture causes adobe to swell and heave. Shrinking follows when it dries out. In paving an 8-mile stretch of road over an adobe subgrade in Butte County, California, special precautions are being taken to resist the action of the adobe The method is described in the August-September Concrete Highway Magazine.

The road passes through level country and the subgrade is thrown up 1 ft. above the natural elevation of the ground. On both sides ditches are dug to assure adequate drainage. The subgrade is then rolled and the grade thoroughly compacted.

A 4-in. mat of gravel is placed over the sub-grade and this is thoroughly compacted with a 12-ton roller. Side forms are placed and the subgrade is then ready for the concrete.

A 6-in slab, 18 ft. wide, of a 1:2:4 mix is used. Reinforcing rods are placed every 18 in. across the pavement about 2 in from the bottom of the slab. Longitudinal reinforcing is placed 3 in. from the edges of the pavement, each rod lapping 18 inch. at the ends.

It is stated that this type of construction has never before been tried in California, but it is believed that with these precautions a pavement will be obtained which will successfully withstand the tendencies of the adobe subgrade to destroy the pavement

The pavement is being built by the California Highway Commission under force account arrangement with the contractors. T. A. Dennis is Resident Engineer in charge and E C. Straucher, Superintendent of Construction

Labor Costs for Street Work, St. Paul, in 1914 and 1919.—The following table from the report for the year ending Dec. 31, 1919, of M. N. Gross, Commissioner of Public Works of St. Paul, Minn., shows the comparative labor costs in the years 1914 and 1919:

	1914	1919
Teams	10-hour day.	8-hour day.
Garbage collection	$100 per mo.	$135 per mo.
Sprinkling	$115 per mo	$150 per mo
Street sweepings	.60 per hr	.90 per hr
Road graders, drags, etc.	.60 per hr	.90 per hr
Flushers and squeezees	.60 per hr	.90 per hr
Hauling paving material	.60 per hr	.90 per hr
Single rigs	.37½ per hr.	.50 per hr
Labor—	10-hour day.	8-hour day
Common, street sweepers (8 hrs.)	$1.75 per day.	$2.50 per day
Common, catch basin cleaners	2.00 per day.	4.00 per day
Common, sewer repairs	2.00 per day	4.00 per day
Common, paving	.25 per hr	4.00 per day
Block setters	.35 per hr.	5.00 per day.
Asphalt rakers	.35 per hr	5.00 per day
Asphalt tampers	.30 per hr.	5.00 per day.
Ward crews	.25 per hr	3.20 per day.

Manufacture and Use of Laboratory Diamond Core Drills

The methods used by the U. S. Bureau of Public Roads in the construction of laboratory diamond drills, are described by Mr. F. H. Schloer, instrument maker of the Bureau, in the July issue of Public Roads. In his article, which is reprinted below practically in full Mr. Schloer also gives some suggestions as to the proper use of the drills

Black carbons or diamonds used for laboratory drills should range from 1/16 in. to 3/32 in. in size and should be dense and regular in shape. Diamonds suitable for the work will weigh in the neighborhood of 0.1 carat each and from 6 to 8 diamonds are required for a 1 in. drill They may be obtained from any of the diamond importers

The diamond drill used by the Bureau consists of a steel or bronze crown soldered to the end of a seamless steel tube about 1½ in. long and 1⅛ in. outside diameter and carrying six diamonds, each about 3/32 in. in diameter. The other end of the steel tube carries a No. 2 Morse taper hollow drill shank through which water is admitted to the inside of the drill. The drill crown proper is made either of Tobin bronze or soft cold-rolled steel, 1 in. internal diameter, 1 7/32 in. external diameter, ¼ in. high, with a recess of 5/32 in. in depth by 1⅛ in. in diameter in which the steel tube is soldered. A detail view of the drill crown showing the various dimensions is shown in Fig. 1.

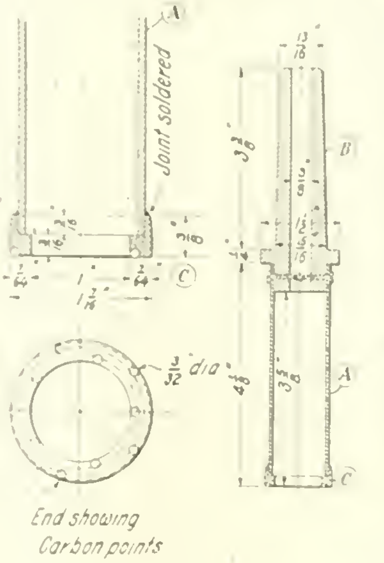


Fig. 1.—Details of Diamond Drill Crown.

Setting Diamonds in Drill Crown. The various pieces of apparatus used in the operation of setting the diamonds in the drill crown, are shown in Fig. 2 A is a piece of cold drawn steel 1¼ by ½ by 6 in., with a yoke C and thumbscrew and is used to hold the drill crowns. After mounting a crown in the clamp as shown, six holes are dirlled in the face of the crown at equal distances apart, three of the holes almost breaking through the outside of the face of the ring and three almost breaking through the inside of the face. The holes should be slightly smaller than the diamonds which are to be used, and each should be slightly nicked on the thin edge with a fine file. A diamond is then placed in one of the holes, gently tapped with a piece of brass so as to hold it in place, after which the crown is placed in a small jeweler's vice D, having jaws of soft steel or brass with which the diamond is forced into the hole. Should the diamond not stand the pressure and crumble it is not fit for drilling. It should be possible to force any diamond good enough for drilling purposes into a hole in the above manner. Flat drills B, made of ⅛-in. drill rod, turned about ½ in. long and of a size slightly smaller than the diamonds, are used for drilling the holes. It has been found that the flat drills are better than twist drills for they are stiffer and do away with a center punch. After the diamonds are all set, the drill is soft soldered to the end of the steel tube and is then ready for use.

Any drill press equipped with a hollow spindle and with the table so arranged that the water carrying the rock cuttings may be properly collected and carried away is satisfactory for use in rock drilling. A drill press equipped with a No 2 Morse taper is large enough. The speed of the drill should be about 300 revolutions per minute

Using the Diamond Drill.—Great care should be exercised when first using a diamond drill. A block of very soft limestone or sandstone should be selected and a number of cores cut from this stone until it is found that the drill is working properly, after which it may be used on harder rock. The sample should be bedded on a bag filled with sand, or in the case of very small pieces it may be necessary to mount the samples in plaster of Paris before drilling. Plenty of water should be used on the inside of the drill so as to keep the space under the crown entirely free from rock cuttings, which, especially in the case of soft rock, have a tendency to "gum up" the drill. After one or two cores have been drilled, their diameter should be measured, and if it is found that the drill is cutting cores more than 25 mm. or less than 24 mm. in diameter, one or two of the diamonds must be reset. If the drill crown is turned to the dimensions shown, however, and the diamonds set as indicated, the cores should come out very close to 25 mm in diameter. The pressure should be applied always by hand and never automatically on account of the tendency of carbons to shatter if subjected to any appreciable impact. When drilling stone by hand, the pressure on the drill may be regulated in accordance with the character of the material being drilled. This is, of course, not the case if an automatic feed is used. A much greater pressure may be used when drilling fine-grained, homogeneous materials, such as trap, even if the rock is very hard, than in the case of coarse-grained, non-homogeneous materials or stone in which minerals of greater hardness than the mass of the rock are embedded. With a properly constructed drill, it should be possible to cut a core 1 in. in length from rock of medium hardness in about 10 minutes. The drills made by the Bureau of Public Roads will cut from 20 to 50 ft. of rock before it becomes necessary to discard them, depending, of course, on the average hardness of the stone being used.

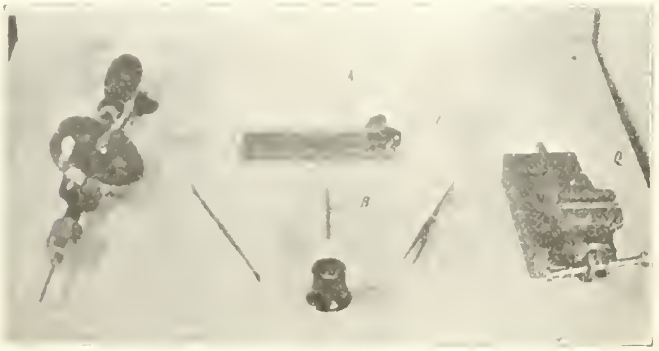


Fig. 2.—Apparatus for Setting the Diamonds.

Horse-Drawn and Motor Vehicle Traffic in Chicago, 1908-1920. A comparative statement of the number of licensed vehicles in Chicago, forming a portion of the report of the Arnold Co. on the S. Water St. improvement, Chicago, brings out quite clearly the progressive reduction in horse-drawn vehicles and the rapid increase in motor vehicles, especially motor trucks, in that city. In 1915, the number of horse and motor vehicles was about equal; in 1920 less than one-fourth of the total was horse-drawn. In addition the total traffic had more than doubled. The statement follows:

Date.	Horse Drawn	Motor Vehicles Pas'gr.	Trucks.	Total.	Total Vehicles.
May, 1908	53,678	5,475	......	......	59,153
May, 1910	58,114	10,289	799	11,088	69,202
May, 1912	55,494	17,452	2,835	20,287	75,781
May, 1914	51,942	27,316	5,044	32,360	84,302
[illegible] 1916	46,187	45,409	9,898	55,307	101,494
May, 1919	32,489	61,731	16,601	78,332	110,821
Jan. 1920	29,092	74,112	19,373	93,485	122,577
		79.3	20.7	100%	
	23.7			76.3	100%

Round Table Discussions at Municipal Engineers' Convention. An interesting feature of the convention of the American Society for Municipal Improvements, St. Louis, Oct. 12-15, will be the round table discussion of technical matters. The convention is reserving half of the main dining room of the Planters Hotel, which is to be set up with round tables, in the center of each of which will be a sign designating some particular subject of importance, such as wood block paving, water purification, city lighting, sanitation, etc. The tables will be in use for breakfast and luncheon during all of the four days, and each will be presided over by an expert with a national reputation in the particular line. Visiting delegtes may change from table to table during the meeting and join in the discussion of the particular subject scheduled.

The Selection and Comparison of Federal-Aid Road Types*

By E. W. JAMES.

Assistant Chief Engineer, Bureau of Public Roads.

In the handling of Federal-aid projects the first point at which purely technical and administrative questions come squarely into contact is in the selection of the type of surface. Very frequently this contact is one of opposition. An ideal condition at this point can only axist when purely technical considerations control, and for this reason there is little hope that the ideal will ever be approximated. Furthermore, it would perhaps be unfortunate for the engineer if he were faced suddenly at the present time with such an ideal condition, for one of the large and still open questions in highway engineering is the selection of type.

Were the engineer thrown back entirely upon technical considerations, it would be found at once that data are lacking on which to come to any definite conclusion. There is some difference of opinion existing in regard to the general merit of the several types. There is little or no unity of opinion as to the service value of the various types under given conditions of traffic and no more uniform views regarding the probable length of life of the several types. On the basis of cost over a period of years, two engineers in one of the large state highway departments have recently published articles with almost opposite conclusions regarding the order in which the higher types of pavement can be placed on the basis of ultimate economy. Data are simply not available for a purely technical answer to the question: What type of surface will give the best results under a set of given conditions?

Engineering, Financial and Local Opinion Considerations in Selection of Types.—We are, however, doubtlessly moving toward the time when we will be able to make an intelligent determination of types on purely technical grounds, and the Bureau of Public Roads as the inevitable clearing house for such information, and as the only governmental organization having at its disposal funds and personnel for conducting the necessary experiments, should and will take a leading part in the necessary research to establish this detail of highway engineering on a much firmer basis than it now rests. Until such time, however, as the results of extensive investigations become available, and no doubt thereafter, it will be necessary to admit several important administrative considerations to a place when types of pavements are under consideration.

First, there are the exigencies of construction to be considered. This involves engineering administration that often meets imperative requirements and results in substantial economies. The present Federal-aid program carries a large number of projects which classify today as earth, sand-clay, and occasionally gravel, but which are avowedly to be completed later by the construction of more adequate surfaces. In some cases the proposed future work is a part of the original plan, but in most of the cases the work is confined to grading and necessary drainage with only such surfacing as may be required to carry traffic during a more or less short interval while the embankments are settling and reaching a condition when expensive pavements may safely be constructed upon them. In a great many projects of this kind, however, no definite plans have yet been made for the surfacing, and such questions as selection of type and raising of funds are postponed more or less indefinitely. The result is that for the present, engineering administration fixes our type as earth, sand-clay, or gravel.

Frequently in planning improvements, it is impossible at any one time to secure the necessary funds to carry out high-type work. It is quite obvious from an examination of the present Federal-aid records that in many cases counties are making their supreme financial effort to provide for the construction of a sand-clay or gravel road. Under conditions of traffic where it is obvious that a higher type of surfacing should be selected, such financial considerations which are purely administrative in nature have the effect of determining the type, regardless of what the highway engineer may recommend. As in the previous case, the final selection of type is in effect postponed until more funds are available.

Finally, and by no means least, we have the influence of local opinion which must be met and given due consideration. The efforts of the engineer in this case should of course be in the direction of influencing the local opinion but he is often one among many, and as he is not paying for the work his recommendations are more likely than not to be disregarded. It is at this point also that the promotion work of men having materials, equipment or proprietary types for sale exercises its strongest influence on the selection of types. As in the other cases referred to, evidence can be found on almost every page of the Federal aid record of projects being determined as to type as well as to location and other details, by the influence of more or less interested local opinion.

---

*Paper presented before a conference of District Engineers of the U. S. Bureau of Public Roads.

Studies for Determining Suitability of Types.—The purely administrative matters referred to thus far will doubtless always be with us, and the time is far distant when purely technical considerations will control in the selection of surfaces but there has been nevertheless considerable work done in the direction of establishing factors for determining with some approximation at least, the suitability of road types for service under given conditions.

For a number of years the Bureau of Public Roads has constructed and maintained experimental roads. Probably the most valuable work done in the course of the experiments has been on surface treatments, and considerable data, incomplete to be sure and only partly conclusive, are available.

In these studies we find, for instance, that a water-gas tar preparation applied as a cold surface treatment, maintained under patrol, will carry 925 gross tons of traffic per day, and under this traffic the maintenance will be in the third in order of economy of seven experimental sections. This same section was destroyed beyond the point of any reasonable maintenance by a traffic of 1,130 gross tons per day. The nature of the effect of 1,130 tons per day was that of an overload which no amount of maintenance could remedy. The average life of a retreatment of this material is eight months. A hot tar surface treatment stood up satisfactorily under 1,325 gross tons daily average and was the sixth in order of economy in the same group of seven experiments.

There is available considerable undigested data of this kind covering seven different experimental sections. This material is now in the process of being analyzed and will probably supply valuable data for the selection of surface treated madadam. It may enable the engineer even to differentiate hot and cold treatments, tars and asphaltic oils, and possibly different asphaltic oils.

The information will in general take the form of the maximum gross tonnage-endurance of the type, the average life of retreatments, the cost of maintenance per ton of traffic, and details of successful maintenance operations.

Probable Limiting Endurance of Road Surfaces.—Attempts to state up to the present time the determination of type has rested largely on the judgment of each individual, so far as technical details are concerned. There is little or no material of value in the literature of highway engineering nor in the engineering press relative to the question. Engineers have written all around the subject, but have generally refrained from committing themselves to figures. We find a few attempts, however, to state the probable limiting endurance of types in terms of traffic and the following indicates the result of one such attempt. The table may be headed "Limiting Economic Traffic on Types of Road Surface."

	Light wagons.	Heavy 1-horse wagons	Heavy 2-horse wagon	Automobiles
Good gravel	50-75	25-30	10-12	100
Oiled gravel			Greater than	100
Do	75-100	30-50	20	500-700
Waterbound macadam	100-150	175-200	60-80	75
Hot oil surface treated waterbound macadam	250-300	75-100	25-50	1 400
Do		Narrow tires, 100	Narrow tires, 50	Trucks, 50
Tar surface treated waterbound macadam	30-50	25-30	10-15	1 800

An older attempt at stating the limiting traffic which various types of pavement may be expected to carry economically was made by the committee on standards of the American Road Builders' Association in their report of 1915. Its tabulation follows:

[illegible]	Horse-drawn [illegible] Light vehicles	Heavy [illegible] wagons [illegible]	[illegible]	Motor [illegible] and busses	Steel [illegible] and tractors
Earth (sand) [illegible]	[illegible]	[illegible]	[illegible]		
[illegible] surface treated gravel	[illegible]	[illegible]	[illegible]	1[illegible]	1
Bituminous Macadam or concrete.					
Waterbound macadam (surface treated)	100-[illegible]	[illegible]	[illegible]	[illegible]	1
Waterbound macadam (cold asphalt oil surface treated)	100-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Waterbound macadam (hot surface treated)	100-[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Waterbound macadam (cold tar surface treated)	[illegible]	[illegible]	[illegible]	10	[illegible]
Bituminous macadam (soft stone)	200 up	[illegible]	[illegible]	[illegible]	[illegible]
Bituminous macadam or concrete (hard stone)	300 up	150 up	[illegible] up	[illegible]	[illegible]
Concrete	100-200	75-150	400 up	10-20	[illegible]
Vitrified brick, stone sets or wood block	200 up	150 up	300 up	20 up	6 up

It is noteworthy that the above indicates that certain types of surfaces may be depended upon to carry somewhat more than is indicated by the careful experimental work of the Bureau of Public Roads. But the range of type in the first table is so limited that it is of little general use, although it fairly represents the best data of the kind available. The table furnished by the Road Builders' Association is altogether too uniform in its enumeration of traffic and for steel-tired vehicles on the lower types of surfaces is much higher than appears to be warranted.

Effects of Heavy Trucks on Roads.—With respect to heavy trucking, the observations of the Bureau of Public Roads are that the effect of trucks rated heavier than 3 tons is generally seriously destructive of any type of pavement designs customarily used on rural roads up to 1917. Further, the destructiveness varies directly with the speed, but probably in greater ratio. It appears that constant use of a few trucks per day if they are heavier than 3 tons and run at high speed, say, 25 to 35 miles per hour, is sufficient to cause high-type pavements of designs current in 1916 to fail as by overload. It is not a question of adequate or economical maintenance in such cases, but of out-and-out pavement failure.

Within the last two years we have been compelled to give recognition to a new destructive force affecting road surfaces. Impact, almost never formerly considered by the highway engineer, is now a force to be reckoned with. It has a close application to the determination of types for certain kinds of traffic, and as high-speed motor trucks are increasing in number rapidly and becoming more generally used, the question of the effect of impact is a serious problem. The bureau is at work determining the force of impact developed by trucks under a variety of conditions. Parallel with these investigations impact test experiments are now ready which, it is hoped, will indicate to some known degree of accuracy the amount of impact which different types of pavement will successfully resist. The correlation of these two sets of experiments should furnish some data useful to the solution of the question: How much truck traffic will a given type stand without failure?

Other experiments to determine the effect of abrasion on pavement surfaces are also under way, and these will furnish further data useful in the selection of types. Obviously, if these experiments are fruitful in results, the engineer will be in a much better position a year from now to face the purely technical considerations involved in the selection of pavements.

Alternate Designs on Federal-Aid Work.—On Federal-aid work probably every district engineer has observed that the question of the selection of types is not the only perplexing matter connected with the subject. There has been during the past two years a continual increase in the practice of using alternate designs on projects submitted. This practice was not common when Federal aid was first inaugurated, but beginning with Indiana, in which state the law requires that tenders shall be asked on at least two alternate types, and with Ohio and Pennsylvania, which states adopted a policy of securing bids on alternate types, the practice has rapidly expanded until today Federal-aid projects, involving the higher types of design, come to the Bureau more often with alternate designs than with a single type. This fact is borne out by the statistics of Federal-aid mileage. At one time when an examination of the records was made for this purpose 12.8 per cent, representing 963.65 miles, was undetermined. Practically all of this mileage was undetermined because a decision as to the type had not been made and would not be made until after bids had been received. This, does not represent all of the alternate work undertaken, as a considerable mileage entered under other types had originally been submitted in alternate form and adjusted when award was made. Obviously, therefore, the question of alternate types has become a serious one in mere quantity and because of the extraordinary questions involved appears likely to result in some very troublesome questions of policy and administration for the Bureau.

Methods of Comparing Types.—The problem has come before the Bureau of Public Roads from so many different angles that it appears almost hopeless to attempt a solution along any of the lines heretofore suggested.

In the first place, Illinois has attempted to set up a rational method of comparing types with at least one very interesting result. Although the conclusion reached is not satisfactory to many engineers and certainly not to a large group of material manufacturers, there has, nevertheless, been surprisingly little unfavorable criticism of the Illinois conclusion, either among engineers or in the engineering press. The reason for this is quite clear—for neither the engineers nor the editors have any better data on which to base objections than the Illinois department had on which to base their conclusions, and the attitude of all concerned appears to be very largely one of "hands off."

The essential feature of the Illinois conclusion is that, studied as a beam, a pavement cross section wholly of concrete is stronger than black top on an adequate base of concrete. The upper layers or wearing surface of a pavement cross-section in concrete is worth twice as much as a black-top wearing surface. Incidental to this conclusion is the use of an identical mix for a one-course concrete design and for the base of black-top construction. Obviously, a rational analysis of this problem has not been made and would be of very doubtful value. It appears to involve the analysis of a compound beam of elastic material continuously, but not uniformly, supported on elastic bearings, and besides the question of flexure involves consideration of no less than three different longitudinal shears, one in concrete, one in black top, and one in the joint between them. The last element can not possibly be evaluated, and the question of reduced impact, owing to the cushioning effect of the black top, confuses the whole problem.

Another method suggested and used by the State of Pennsylvania in the specification current during 1919 is to establish comparable types on the basis of probable cost. For this reason, Pennsylvania in the standard specifications for 1917, developed designs for such pavements as sheet asphalt, Filbertine and Warrenite, having dimensions which depart from previous customary practice. These designs were built up with the sole end in view of producing a cross-section in each type of substantially equal money value. Obviously, the problem is reduced to a hopeless dilemma by attempting a solution of this kind, because if on the basis of cost a logical solution is attempted it must be revised as the costs of materials vary, but in so doing it becomes distinctly illogical from the technical viewpoint.

Another solution of the problem of comparable and alternate types which has been tentatively followed by the Bureau of Public Roads starts by establishing a list of pavements on the basis of service value. This is purely empirical and indeterminate because it is likely to vary somewhat in the judgment of different engineers. The order in which pavements have been listed by the bureau is as follows:

Brick on a concrete base.
Sheet asphalt on a concrete base.
Cement concrete.
Bituminous concrete on an adequate base.
Bituminous macadam.
Surface treated macadam.
Waterbound macadam.
Gravel macadam.
Gravel.
Sand clay.
Top soil.
Earth.

Group Classification of Types.—Quite clearly there may be a difference of opinion as to the position of cement concrete and bituminous concrete in the above list and it is equally clear that a lower type may, by superior detail of design, be made to excel a higher type in the list. The next step, therefore, was to attempt to indicate sufficiently the details of design so that the pavemeents could be classified in groups. This classification follows:

Class A for heavy traffic:
  (1) Monolithic or semi-monolithic brick pavement using 3-in. or 3½-in. block on cement concrete base, 4 or 5 in. deep, 1:2½:5, or 1:3:6 mix.
  (2) Bituminous concrete, 2 in. thick, on a 6 or 5-in. cement concrete base, 1:3:6 mix.
  (3) Cement concrete pavement, 6 in. thick at the sides and 7½ in. at the center, 1:2:4 mix.
Class B for medium traffic:
  (1) Bituminous concrete, 1½ in. thick, on a cement concrete base 4 to 5 in. thick, 1:3:6 mix.
  (2) Cement concrete pavement, 5 by 6½ in., 1:2:4 mix .
  (3) Bituminous concrete, 2 in. thick, on a 4-in bituminous concrete base of crushed stone or gravel.
Class C for light traffic:
  (1) Bituminous concrete, 1½ in. thick, on a bituminous concrete base, 4 in. deep, of crushed stone or gravel.
  (2) Bituminous concrete, 1½ in thick, a bituminous binder course 1½ to 2 in. thick, on a 4-in. broken stone base.
  (3) Bituminous concrete, 2 in. thick, on a waterbound macadam base 5 in. thick.
  (4) Bituminous macadam, 2½ in. thick, on a 5-in. waterbound macadam.

This classification was especially devised as a suggestion for the State of Idaho, and there was included under class A for heavy traffic as a fourth alternate, bituminous concrete, 2 in. deep, on a 6-in. or 5-in. bituminous concrete base of crushed stone. This addition was solely for the purpose of providing in this group a type of surface that did not require water in the building. Consideration of these groups indicates at once that the classification is not of a kind to be generally applicable. Class A pavements would be made considerably heavier in most of the Eastern States and numerous other variations in detail would have to be made for other localities.

So many different questions have arisen regarding the determination of alternate and comparable types that it appears necessary to seek a solution in an entirely different direction. So far we have attempted to establish an equivalency of either cost or service value. It is doubtful whether this is possible in the light of our present knowledge and it appears likely that when further data is available this doubt will be converted into a certainty.

Normal Differentials Among Types.—It has, therefore, been suggested that an attempt be made to establish normal differentials, among the several higher types that are likely to be brought together in competition. This normal differential presupposes the fixing of what may be referred to as a normal base price for each type on a given project, and this will be arrived at by a careful analysis of the materials entering into the construction of the design on the basis of their cost. Given a particular project on which it is intended to solicit tenders for sheet asphalt, modified Topeka, and concrete, the materials necessary to construct each type will be located and the cost of placing them into the work will be analyzed. This will provide for each type a very carefully compiled engineer's preliminary estimate. It need not represent the actual cost, but it will establish a normal basis of comparison and fix the normal differentials that may be expected to exist between various types. This will be done, of course, in advance of the bidding, and the engineer, and assumably prospective contractors, will have advance knowledge of these differentials.

When the bids are opened, if the bid for concrete is below its normal base price and the bid for Topeka is above its normal base price, the concrete would be considered the better bid. If, on the other hand, sheet asphalt, although bid at a considerably higher cost, were below its normal base price, and concrete above its normal base price, the tender for sheet asphalt could logically be considered as the better bid. Assuming, therefore, that in the premises the types have all been established as adequate and reasonable for the traffic likely to develop on that particular project, then the engineer would be logically justified in awarding a contract to sheet asphalt, although it might be the highest bid in dollars and cents. The practical effect of this method is to avoid a decision as to strictly comparable types or designs, and at the same time maintain competition. But that competition is no longer among the types it is a competition of each type with its normal or base estimate.

It is, of course, at once apparent that a suggestion of this kind can only be worked out under very intelligent engineering direction. The policy of blindly assuming costs based on previous averages of bids must be abandoned. Likewise, the custom so apparent now in Federal aid estimates of assuming a single price of $2.75 or $3.50 for surface, regardless of the type, simply for the purpose of establishing a preliminary estimate will have to be discarded. It will mean that the engineer after having selected his alternative designs will first have to compute the quantities of cement, sand, chips, aggregate, bitumen, filler, and whatever other materials enter into the construction, locate probable sources of suitable materials, and carefully analyze the cost of each one. The organization of a mixer gang will have to be known within a narrow margin, based on the probable method of construction prevailing and likely to continue in the particular locality. Similarly, any construction organization which may be required by the design selected will have to be understood and labor costs analyzed. It is probably not possible to generalize in these matters and estimates would be required for each project coming under consideration.

Whether this scheme is practicable from a business point of view may be open to some question. It has some decided advantages. For instance, it has been noticed that concrete bids when brought into competition with bids for Topeka or Warrenite on a concrete base have a marked tendency to rise until they are only slightly below the Topeka bids. If a differential was established concrete would have to stay down where it belongs or it would be at a disadvantage. The cost of preparing preliminary estimates would be somewhat greater than at present and the estimates could not be based so generally on averages derived from records of past bids as they now are. It is probable also that a somewhat higher standard of preliminary engineering in general would be required to carry out this scheme successfully because there would doubtless arise considerable differences, especially among material men, as to the fairness of the differentials established and the engineer responsible for the computations would have to fortify his conclusions by very skillfully analyzed data.

American Colleges to Establish Course in Management Engineering.—A course in "management education" to provide a sufficient number of properly trained executives for the industries of the United States is to be established in a majority of the 620 American colleges, according to an announcement made last week by Dr. Hollis Godfrey, president of the Drexel Institute, Philadelphia, formerly commissioner of the advisory commission of the Council of National Defense. The plan, an outgrowth of a convention attended by representatives of industry and colleges in Philadelphia last March, is backed by corporations representing a capitalization of $26,000,000,000. It is the result, Doctor Godfrey said, of these two factors coming to a definite working agreement for the first time through the establishment of the council of management education, an organization formed "to study mutual problems in order that the colleges may render the greatest possible service to industry." Doctor Godfrey, chairman of the new body, assisted by Dr. Samuel P. Chapen, general director of the American council on education, representing the 620 colleges, and Dr. Frederick C. Ferry, president of Hamilton College, are perfecting the plan, which contemplates establishing practical courses in the schools, assisting undergraduates and others to choose their life's work, by placing several thousand students and teachers in industry during the summer months and by introducing extension courses for men now in industry. By the summer work, students will be enabled to defray their expenses at college, obtain an insight into America industry, and enable the executives to select future management men. The council of management education, which has been formed, it was said, to become "a clearing house for all industrial and educational matters in the country, to promote the mutual understanding of the mutual problems of industry and the college, and to keep perpetual inventory of the educational needs of industry and of the ability of the colleges to meet these needs," has opened temporary offices in the Drexel Bldg., Philadelphia, until headquarters are furnished in Washington.

Method of Constructing Durax Pavement

By W. C. MALLONEE
Assistant Treasurer, Robert G. Lassiter [illegible]
N. C.

Durax granite block pavement has been laid in a number of our larger cities, but is not generally known by the public as yet. The method of construction varies, each engineer having his own particular method prescribed, which in accordance with his experience, is the most successful. The variations in details are experiments which will result in improvements as this pavement becomes more generally used. We are now constructing 65,000 yd. of Durax and the outlined methods given below are, from our experience on this and other Durax work, the most satisfactory.

The Durax surface is laid upon a concrete foundation of such a mix and thickness as is necessary for the traffic conditions. The construction may be divided into three operations: (1) mixing and spreading a sand and cement cushion, laid upon the concrete foundation; (2) laying the block upon the sand and cement cushion, and (3) filling the joints of the Durax block with a hot mastic filler composed of asphalt and sand.

Laying Durax Pavement.

The sand cushion is mixed on the street directly in advance of the pavers. It is composed of 1 part cement and 3 parts clean, coarse sand. The sand must be mixed thoroughly dry and the cushion kept dry to prevent initial setting until the blocks have been tamped and rolled. Some engineers require the sand heated in a dryer to take out all moisture. The mixture is spread with shovels over the street extending about 10 ft. behind the pavers. Care should be taken not to allow the cushion to be spread far in advance of the paving, especially in threatening weather.

A 1-in. cushion is generally specified, but experience has shown that the average depth of the cushion can not be estimated accurately and is dependent upon the thickness and uniformity of the block. Frequently the block from different quarries and even from one quarry, vary in size. It, therefore, becomes necessary to keep the concrete foundation low enough to allow 1 in. cushion under the largest block, if proper contour and grade of the finished surface is maintained. For instance, if the concrete is laid exposing 5 in. for the finished surface, 1 in. for cushion and 4 in. for block, and the block received average only 3 in., a 2-in. cushion would have to be used. If, on the other hand, the foundation was laid exposing 3 in. for the finished surface, 1 in. for cushion and 3 in. for block, and the block received average 4 in., the finished surface would be an inch too high. This would have to be repaved with smaller selected block. Accordingly, we allow for the largest block received on the work, which means the average depth of the sand cushion is considerably more than specified. We have never yet received such uniform block regularly in large enough amounts to warrant our allowing only the specified thickness of the cushion to effect this saving. This, in our opinion, is one of the most trying and difficult features of Durax construction and the expense involved can be overcome only by re- ers for wheeling Durax, mixing and spreading the cushion ceiving block of such uniformity that the foundation can be laid for only specified depth of the cushion, so that the depth of the block will insure proper grade of the finished surface.

The Durax block or cubes are cut from medium grained granite having a very high crushing strength, usually 25,000 to 30,000 lb. per square inch, with a toughness usually of 11 or 12. The blocks are cut with six square surfaces, the latitude usually being not more than 4 in. nor under 2¾ in.

The block are laid in "concentric interlocking segments" or in the form of an arc, using a curvate board to maintain the proper curve. This curvature is purely arbitrary and is based upon personal experience and opinion. We are now using a board 4 ft. in length on the straight edge with a middle ordinate of 12 in.

The street to be paved is divided with lines into sections the width of the curvature you are paving. This division into sections is started from the center of the street so that the half or quarter circles where necessary will be alongside the curb or street rail. Half and quarter circles are used when the street does not divide exactly into full circles. The area between street car tracks is 4 ft. 8½ in. If you are paving with a 4-ft. board there is no way a full circle could be used and two half circles would be necessary to take the entire area. In this manner a plot of the street must be made to determine the half or quarter circles necessary and the street lined accordingly.

Partially Completed Pavement, Showing Boards Used for Maintaining Proper Curve.

Each paver is given the area of a section between lines to pave. These lines are used as a starting point for each circle and to give proper grade. The paver begins each row with a block placed directly under his line, which is called "keyblock" and is the connecting link between each circle, joining the work of one paver to another, thus making concentric segments across the street. This keyblock must be carefully selected with a view to starting each row with such a size that by graduating the block to the center of the arc the proper curvature will be maintained throughout the row as shown by the radius board. The keyblock is the starting point of each row and should be set to a true grade as the paver is guided in laying other block by this keyblock. When this block is set correctly proper grade can be maintained throughout the entire row paved. The back of the radius board is a straight edge and this should be used frequently every two or three rows.

The Durax is wheeled by helpers into each section and is piled so close to the paver that he can easily reach them from a kneeling or standing position.

Starting at the keyblock of each row the paver works on either side toward the center of the arc. The block are laid as close together as possible with not more than ½ in. between joints. Each block is tapped gently with a hammer to set it firmly against the other block and to imbed firmly into the cushion. The back of the hammer which is curved 6 or 8 in., is used for pulling up cushion, digging into cushion and for prying up block not correctly set. "Breaking joints" is always to be insisted upon. This means the joints of block in one row can not meet evenly the joints of the preceding row, but must meet directly the full face of the block.

In a gang of 10 pavers it will require about 10 to 12 helpers. The helpers are usually paid by the day as laborers, but the pavers usually work on a yardage basis. This work can be done with dispatch only by experienced men who must have a good eye for maintaining grade and curvature and show due regard in selection of block which will break joints. An experienced paver will lay 20 to 30 yd. per day, depending upon the method prescribed. It is easier to pave a broad rather than a sharp curvature. A greater yardage can be paved per day with large block than with small block, but the yardage yield per ton of small block is more than the yield of larger block per ton. One ton of Durax can be estimated to pave 6 or 6½ sq. yd.

The yardage paved each day is tamped firmly and rolled with a 5-ton roller until there are no depressions greater than ⅜ in. under a 4-ft. straight edge. Should any depressions exist greater than this, it must be torn up and re-paved. After the pavement is rolled and passed by the inspector each day it is thoroughly wet with a hose sufficient to insure proper setting of the cushion.

After the Durax is thoroughly dry a mastic filler composed of equal parts of hot asphalt and sand is applied to the block, filling all joints completely. The asphalt, of a penetration of 55 to 65, is heated in kettles to a temperature of at least 225° F., the sand to at least 250° F., and mixed in wheelbarrows or other suitable containers. It is then poured upon the block at such a temperature that it will run freely and fill all joints. The back of a rake is used to good advantage in spreading the mastic filler so that an even, thin layer will remain on top. A thin layer of dry sand is then spread over the mastic surface. Eight or 10 men are required to heat and mix the asphalt and sand and pour over the street.

While the construction is rather tedious and slow, especially at this time with labor and material conditions so chaotic, we think upon their return to the normal again this undesirable feature can be successfully eliminated and a popular usage and knowledge of this pavement will also develop experiments and ideas which will no doubt tend to increase efficiency in construction and give still more value to the pavement's inherent good qualities.

Schedule of U. of M. Graduate Short Period Course in Highway Engineering

The 1920-1921 schedule of graduate short period courses in highway engineering and highway transport at the University of Michigan has recently been announced. This university is probably the only educational institution offering graduate short period courses, arranged especially for men engaged in the practice of highway engineering and highway transport. The schedule follows:

December 8 to 21, 1920.

Highway Engineering Theory, Design and Economics. Professor Blanchard.

Grading Machinery and Operations. Professor Bateman.

December 27, 1920, to January 7, 1921.

Highway Transport Surveys. Professor Blanchard.

Highway Specifications, Contracts and Jurisprudence. Professor Riggs.

January 10 to 21, 1921.

Earth, Sand-Clay, Gravel and Broken Stone Roads. Professor Bateman.

American and English Highway Transport Methods. Professor Blanchard.

January 24 to February 4, 1921.

Bituminous Surfaces and Bituminous Pavements. Professor Blanchard

Bituminous Materials. Professor Bateman.

Inter-relationship of Highway, Railway and Waterway Transport. Professor Riggs.

February 7 to 18, 1921.

Mechanism, Operation and Maintenance of Motor Trucks, Tractors and Trailers. Professor Lay.

Highway Laboratory Research. Professor Bateman.

Highway Structures. Professor Gram.

American and English Highway Traffic Legislation and Regulations. Professor Blanchard.

February 21 to 25, 1921.

Seventh Annual Michigan Conference on Highway Engineering.

February 28 to March 11, 1921.

Brick, Cement-Concrete, Stone Block and Wood Block Pavements. Professor Bateman.

Highway Engineering Seminar. Professor Blanchard.

Highway Transport Management, Costs and Record Systems. Professor Blanchard.

March 14 to 25, 1921.

Highway Engineering Financing, Administration and Organizations. Professor Blanchard

Highway Transport Seminar. Professor Blanchard.

Method of Resurfacing Worn Brick Pavements in Topeka with Asphaltic Concrete

By W. E. BAILEY
City Engineer, Topeka, Kan.

The city of Topeka, Kans., has some 120 miles of pavement, varying in width from 20 ft. to [illegible] ft., a large percentage of which was laid between the years 18[illegible] and 1910. This particular paving was of 2-course brick construction, the lower course being No. 2 quality brick construction, laid flatwise upon a sand bed thrown over the subgrade. Over this course a heavy sand cushion, at times reaching some 3 or 4 in. in thickness, was spread, and another course of brick of No. 1 quality was laid on edge, and finished with a sand filler. These brick were made largely in Topeka, and while of good quality perhaps as brick were made at that time, still they would not make the standard rattler test required of brick today.

With the changes in type of traffic that has taken place since this type of paving has been laid, together with the wear it sustained previous to the appearance of the motor truck, a large part of the work reached such a condition that it was better to avoid these streets than to attempt to travel upon them with any degree of comfort or speed, they were, however, still usable for heavy hauling, and wagon traffic.

A number of the streets, paved as above indicated, are residence streets, and, also a number of them were heavy traffic streets in the bottoms, carrying wholesale district traffic and coal yards. In a number of instances, the abutting property owners refused to sign a petition to repave these streets, because of the fact that the traffic upon them originated elsewhere, and it was a matter of no particular concern to those who would have to sustain the cost of repaving, whether the street was easily passable or not. The city government could of course order the repaving of the streets, but in an attempt to overcome this action, and yet restore the streets to a more passable condition, it was decided to place asphaltic concrete strips, 16 ft. wide, down the center of streets on which no car tracks existed and two strips each 8 ft. wide on streets having car tracks.

The first plan was to fill up the holes over the area of the street occupied by the strip, first with a binder mix, then to add a 1-in. strip over the whole area, tapering the sides down to a feather edge. To do this work the streets were first well swept, which on account of the sand filler, left deep crevices between the rows of bricks, furnishing excellent clinches for the binder coat. The next step was to heat No. 54 Texaco asphalt to a liquid condition, and unite it with domestic distillate, which is the next heavier grade of oil below common coal oil, in the ratio of 40 per cent of the distillate, and 60 per cent of the asphalt. These were usually mixed in a half barrel and while hot poured into common house sprinkling cans. The workmen then started up and down the street at a moderate walking speed, pouring on the paint coat as they went, the result being that the entire street was covered with a very thin coat of this material, which took care of all the dust, entered the pores of the bricks, and put the street in fine condition for the asphalt work. This coat was allowed to dry for about 24 hours, depending upon the weather conditions. We considered it safe to apply the binder coat when the paint coat failed to leave any stain on the finger when pressed against it.

Following the application of the paint coat, we applied the binder coat, with which we filled up the depressions and made the roadway generally suitable for an even thickness of the wearing surface. This binder coat, is made of a mixture known as a close binder mix. The stone was graded down from a ¾-in. size to a ¼-in. size, then Joplin flint or "chats," together with three sand gradings were employed, and stone dust or portland cement used as the filler material.

The proportions used in making the binder coat will vary materially with the aggregates used, if the coarse rock is crusher run there will be a percentage of screenings in it, likewise the "chats" will vary as to fineness.

This binder when laid should be firm and tough after rolling, should show no "greasy" spots of harmful size, and yet should be to a certain extent porous, giving ample hold for the wearing surface to key to the binder coat.

The following is a mix for the binder [illegible] of the work which will average well in [illegible] practice, it being changed as conditions [illegible] that gives a satisfactory product. Total weight of [illegible] lb., asphalt cement 225 lb., filler 150 lb., [illegible] 14[illegible] lb. and stone 2,000 lb. From the above the percentage of each product may be derived. The exact [illegible] of the fine, medium and coarse sand to use must be determined from the material at hand, as a rule about one third of each, and vary from this as the gradations of the mix demand. The binder should be of such toughness and mixture that it will not be disturbed by the hauling around upon it of the wagons and teams or trucks bringing in the wearing surface later.

After having applied the binder coat for about a day's run of the plant, the next day is devoted to the wearing surface. In laying these strips as stated above, they were first laid thin, it being intended to make them only approximately an inch thick. Under this intention, the nature of the rough brick on the street made places where this strip was less than an inch thick, for we did not in this strip work lay a binder coat over the entire street to be covered by the strip. We used the binder coat only to level up the bad holes, or long depressions, hence when the roller came on the hot stuff it came near going through at the "peaks." Experience has taught us in this matter that it does not pay to lay this wearing surface less than 2 in. thick, especially in this strip work, for it must be kept in mind that as soon as these strips are laid, they receive the entire traffic of the street, and, where on car track streets we laid a strip each side of the car tracks 8 ft. in width, it confined the entire traffic to two narrow strips on each side of the main strip, about 18 in. in width, and this, together with the fact we made no especial provision for "headers," put a severe test on the strip work. We have found that certain kinds of traffic, for instance a 4-in. tire wagon hauling coal in July and August when the asphalt was at possibly 110 or 120° F., was able to make the mix "flow" in spite of everything, and eventually then to shear off from the main strip. In repairing these strips now we take care to make the strip full 2 in. thick, and we slope the sides down to the old brick paving at about a 45° slope. For the wearing surface, we use practically the same mix as we do for new work in asphaltic concrete, excepting that about 2 per cent more of asphalt is carried in the mix than is used in the regular new paving work.

Following the use of these strips, as above outlined, the residents of Topeka Ave. petitioned the Commission that their street be resurfaced with asphaltic concrete, in such manner as deemed advisable, but with the idea of making a permanent improvement. This petition was received and acted upon favorably, with the result plans and specifications were drawn in 1917 for the improvement. This street was also a 2-course brick construction paving, having been in service some 20 odd years. This street, like many others, had been dug into for various reasons, until its surface was well nigh impassable for pleasure carriages. This street is the choice residence street of the city, being reserved from use by the street car system. All the street crossings were of the raised type, giving bridges across the gutters, the brick paving forming the gutters, and the curbs were built of red sandstone.

Owing to the 2-in. of additional wearing surface expected to be placed on the present brick, it was designed that a new concrete gutter should be built next to the present curb, of 30 in. width, and 6-in. thickness, this thickness being the depth of the wearing surface of the brick paving plus the sand cushion under it, leaving the first brick course in place as a foundation for the new gutter. The flow line of the gutter was made to conform to the flow line of the old brick gutter, but the outside edge was raised above the present brick level 2 in. to form a shoulder for the new wearing surface.

After construction of the new gutters, the raised crossings were removed, and where the removal required the cutting through of the first course of brick we supplied a concrete base for the new surface, but where we were able to leave in the first or flat course, we did, with the result that at the time of beginning the binder course our street was a series of large and small areas approximately 4 in. below the general level of the brick street surface. Over these places where we were leaving in the first or bottom course only, we swept these brick clean and grouted them well, likewise the many rough and uneven places in the street were treated in like manner

The work of preparation being complete the street was cleaned and the paint coat applied as above described, and later followed by the binder coat. The binder coat was used to level up all of these depressions created by the removal of the raised crossings, and the joining of this street to adjoining streets, also to take care of the many irregularities in the general contour of the street. This binder was made of substantially the same mix as described above, raked and rolled with the same care as would be used for surface coat, and left in condition for the reception of the wearing surface.

As a matter of street operation it was found better to lay binder coat for one day, then followed the next with wearing surface, the binder coat being kept from street traffic so that it would be perfectly clean. It will be seen the binder coat was in places 4 in. thick but as these areas were small and surrounded with brick side walls, no trouble was anticipated and none has been found to take place.

In letting the contract we wrote our specifications and the contractors bid on a 2-in. wearing surface, and a 1-in. binder coat. We used the binder as needed, and upon such parts of the street as were in good surface condition, no binder was applied. We found upon closing up the job we had used a little less than the average 1-in. thickness of the binder over the entire street. We let this contract in the summer of 1917 at a cost of 90 ct. per square yard, which included the binder coat and the 2-in. wearing surface, the new gutter being extra, and the removal of all old surface extra. The following year we let three more blocks of the same work at a cost of $1.10 per square yard. This street has been in constant use since its reconstruction, has carried probably 100 per cent more traffic than properly belongs to it, and at this time shows no signs of distress. Our people are very well satisfied, and we anticipate considerable more of the same class of work to be called for as soon as paving prices are returned to normal condition.

Simple Device for Unloading Aggregate from Gondolas

A simple device for unloading sand and stone from gondola cars into motor trucks was used for a 2½ mile concrete pavement job in San Joaquin County, Calofornia. The arrangement is described in the August-September Concrete Highway Magazine. A shallow pit was dug beside the railroad spur where the gondola cars are delivered. The motor trucks back up into this pit to receive their loads. The capacity of the trucks used was 2½ tons of sand or stone. A timber "A" frame was set up beside the track, held in place by guy ropes. This carried a small bin holding 2½ tons, at an elevation corresponding to the top of the gondola cars. A cable operating through a pulley at the head of the "A" frame drew an ordinary slip scraper inside the car, by means of which the small suspended bunker was filled. The cable ran through the top of the "A" frame to a drum operated by a 6-HP. gasoline engine. The aggregate was drawn into the small suspended bin by this device, where it was held until a truck is ready to be loaded. The bin discharged its contents through a movable gate end. The small bin could be filled with aggregate while a loaded truck was pulling out of the pit and another one was driving in.

When a car of aggregate had been unloaded, the guy ropes holding the "A" frame were loosened and the frame was tilted away from the track to clear the gondola while a new car was spotted. The entire operation of loosening the guy ropes, moving away an empty car and spotting a filled one, required only [illegible] minutes. Four men were required to operate the device, one man running the gasoline engine and winding drum, another man handling the bin and discharging its contents into the trucks, and two men handling the scraper inside the car.

Before this equipment was installed, the cost of unloading aggregates by hand varied from 23 to 34 ct. per ton; the cost of unloading with the device described was 15 ct. per ton. The device could handle 250 tons of material in 8 hours, although the average daily requirement was about 175 tons.

The pavement was constructed by the forces of the California State Highway Commission under the direction of F. C. Hewitt, Resident Engineer, and W. B. Albertson, Superintendent of Construction.

Large Stock Piles and Efficient Working Organization Expedite Concrete Road Job

A concrete road job now under way near Charleston, Mo., involves some interesting construction features. The contract covers 15.3 miles of 16-ft. wide 2-course pavement. The bottom course is a 1:3:5 mixture and the top 1:2:3 mixture with granite as the coarse aggregate. Anticipating transportation difficulties, the contractor organized his gangs on such lines as enables him to shift them to the grading whenever the cement gives out. For this purpose, the grading, which is light, is not permitted to get very far ahead of the paver.

Storage Bins and Stock Piles.

As a further step toward expediting the work, the contractor early in the season began accumulating large stock piles of aggregate. Opposite each pile he erected a small storage bin. The standard gage track layout permits unloading material cars into the stock piles or into the bins, as desired. When material cars are at hand, he unloads directly into the bins. When he is out of material cars, he loads his bins from the stock piles.

The equipment used on the work includes an industrial railway, three 4-ton Whitcomb locomotives, 50 Western trucks, 100 Western oak batch boxes, 30 cu. ft. capacity; a Koehring paver, Osgood crane, and a Lakewood finisher.

The industrial train passes under the three bins and is there loaded by gravity with the aggregates. The two batch boxes on every fourth car are loaded with material for the top course, and so labeled with a tag. This train then passes through the cement house where the cement is added to the batches, an extra amount being placed in those boxes which are tagged.

Unloading Batch Box at Mixer.

At the mixer the six batches of material for the foundation course on the first three trucks are put through the mixer and spread, and then the two batches on the fourth truck containing material for the top course, are put through and spread on top of the other, and so on. This plan has been very successful.

The maximum number of men around the mixer is one foreman, one mixer engineer, one fireman, who also handles the small transfer crane, three men handling batch boxes and spotting cars, three spreaders, one finisher and one water boy. In the material plant are one crane operator, who also aids as fireman; two men loading aggregates and two men loading cement. The maximum day's run has been 503 ft. in 8 hours. Roy Williams, Wyatt, Mo., is the contractor.

Cost of Street Cleaning at St. Paul, Minn.

The city of St. Paul has a land area of 52.17 square miles and a water area of 3.27 square miles. There are 295 miles of roads, graded only; 45 miles of macadam roads; 17 miles of graveled roads; and 96 miles of paved streets and 5¾ miles of paved alleys. The paved area—streets bridges and alleys—amounts to 2,438,000 sq. yd. The following particular regarding the street cleaning service in 1919 are taken from the annual report of M. N. Goss, Commissioner of Public Works. Fifty-eight miles of paved streets, or an area of 1,365,000 sq. yd., are cleaned by hand sweeping under the patrol system. The force consists of an inspector at $125 per month, assistant inspector at $110 per month, 105 to 125 sweepers and 15 shovelers at $2.50 per day of 8 hours and 14 teams at 90 ct. per hour. The total cost of the patrol system, including hauling away the sweepings, was $98,507, or an average cost of $72.17 per 1,000 sq. yd. swept for the season. Each sweeper, in uniform, is assigned to a district and sweeps and patrols from 3,200 to 17,000 sq. yd. daily.

A total of 280,000 sq. yd. within the patrol district is street railway pavement and the companies were charged $23,806 for their portion of the cost of this service.

In the business district paved alleys are swept once a week by a sweeping crew consisting of two teams and four men. Rubbish receptacles at street corners have their contents removed by single team and one or two men to assist.

The city purchased an Elgin auto sweeping machine in 1918. This machine is used in sections of the city outside of the patrol district and will clean approximately 80,000 sq. yd. per day at a cost for operation of 8 ct. per 1,000 sq. yd. The balance of the paved area is kept clean by the ward crews.

Snow removal, including the sanding of walks and steps, cost $30,445. Of this the street railway company paid as its portion $6,429. In February alone there was removed 23,764 loads of snow at an average cost per load of 70½ ct. The total amount charged to snow removal for that month alone was $17,346.

The city owns 7 Studebaker flushers, 6 of which are operated continuously on day shifts and 3 on a night shift; also 8 squeegees or scrubbing machines, which are used on smooth pavements, such as asphalt and creosoted block.

The streets in the business district bounded by St. Peter, 8th, 3rd and Broadway, inclusive, are flushed at night. There are 7 miles of paved streets, or an area of 146,400 sq. yd., in this district. The crew consists of a foreman and 3 teamsters. They work 8 hours. The average cost of operating these three flushers on this night service is $33, or the cost per mile of street per night is $4.61 and the cost per 1,000 sq. yd., 22½ ct. These costs include payroll, oil, waste, gasoline and water, but not repairs to equipment. The average cost of squeegeeing in the business district, but outside of the night district, was 16 ct. per 1,000 sq. yd. for one scrubbing. This does not include the cost of cleaning up the gutters, as this service is performed by the teams hauling street sweepings. All paved streets in the residence district are either flushed or scrubbed once a week and oftener where necessary; 45,092,378 gal. of water were used by the flushers and squeegees, of which 8,960,629 gal. were paid for by the Street Railway Co.

In all, 171 miles of streets were water sprinkled and 164 miles treated with oil during the season. The oil was spread with two Kinney auto oilers. For the water sprinkling the city furnishes tank wagons and hires the teamsters, paying them $150 per month. The 1919 rate for sprinkling, two round trips per day, was 7½ ct. per front foot, or $3 for a 40-ft. lot. The rate for oiling for the average width street (27 ft.) was 7 ct., or $2.80 for a 40-ft. lot. This was for two oilings during the season.

Education of the Highway Engineer*

By BRIG.-GEN. C. H. MITCHELL
Dean of the Faculty of Applied Science and Engineering, University of Toronto

The development of our highways has acquired such prominence that they are now among our most important public utilities. With the greatly increased activity in the construction of our highway systems, we find ourselves examining into our preparation and our facilities for the carrying on of these highly necessary and important undertakings. In this preparation we are beginning to realize that provision for adequate engineering, with its many branches, stands much in need of attention from all of us who are concerned in these utilities, and we realize that if we are to proceed along sound lines for the development of our highways we must be assured that a sufficiently large number of trained engineers of the several types required are forthcoming to carry on the work in its various phases. Too much importance cannot be attached to the quality and training of those who are to be intrusted with the engineering of our highways. As we look forward to the future of highway engineering for the next decade, or more, we can see that there will be a very considerable demand from all parts of the country for engineers trained in these various branches and when the diversified forms of engineering are considered we realize at once that the field to be supplied is larger than at first appears.

To those actually engaged in the larger construction of our highways in our municipal, provincial and national program, the necessity for wide experience on the part of their engineers must be increasingly apparent and it is more than ever essential that their particular fitness for the various special branches of engineering should be assured.

The Broadness of the Highway Field.—The diversity of these various branches or special kinds of engineering which are now included in, or necessary to, the broad subject of road building is not fully appreciated by the public nor, indeed, by but a few of those outside of the technical services, engaged in the work itself. There was a time when a road or highway was just the roadway itself, so far as engineering is concerned, and it was treated in this light and roads were built or grew and were maintained, if at all, with the employment of the simple engineering methods or the application of but the most elementary principles of applied science. But nowadays, like all other similar undertakings, the complexity of today's requirements and life has laid a much greater burden on those who are charged with the carrying out of the technical side of highway construction.

For instance, we naturally think of highway work as a branch of the broad subject of civil engineering, and so it is. But when one considers at length the various features involved, not only in the actual road building but the closely related problems which accompany it, it is found that, as an engineering question, the so-called specialty embraces many features of other branches of engineering, such as mechanical, chemical and even electrical, with all of which the well informed and broadly trained highway engineer should have no small acquaintance.

Some Things the Highway Engineer Must Know.—It is not sufficient that the civil engineer engaged in highway construction should have good experience and abilty in land survey work, topography, cross-sectioning or mapping, or skill in the location and the balancing and computation of quantities involved in excavations and embankments or in grades and drainage or in foundations, or aptitude for the patient and laborious attention to office detail which goes with a well organized engineering staff. But he also must have a degree of experience—perhaps even to the degree of being an expert—in the design and construction of steel and concrete bridges and culverts, retaining walls and those many concrete structures incidental to roads of all classes.

To consider the subject broadly he must be also a student of meteorology and understand the climatic conditions and their effects and he must know something of geology and even of petrology where concerned with the qualities of road metals. If he is concerned with paving and roads and streets in closely settled areas he has a highly specialized field before him in the study of the sources, properties, preparation, construction, behavior and maintenance of all kinds of paving materials from gravel and stone to wood and asphalt. But that is not all, for he must be prepared at all times, when building such roads and streets, to deal with the continuously occurring problems involved in taking care of water pipes and sewers, of street railway tracks, or railway crossings and their protection and operation and of the increasingly difficult electric line crossings, whether telegraph, telephone or high tension electric power lines.

---

*From a paper presented at the 7th annual convention of the Canadian Good Roads Association, Winnipeg, Man., June 1-3, 1920.

But the engineer in this work, if he is to be really up to it, must be more than a civil engineer, for, as pointed out, he must have a knowledge of mechanical and electrical and chemical work as well following present day progress. Not only must he be conversant with the underlying principles of traction, but he must have a practical working knowledge of the mechanical and electrical machinery and equipment used in the processes of manufacture and preparation of materials and in the construction of roads.

The varieties of such equipment—those for instance for handling materials in excavation, quarries, sand and gravel pits, and in the preparation of them by crushers and screens, or the machinery used in construction, such as concrete mixers, road rollers, asphalt, tar and similar plants—are in themselves such important factors in road building as to demand close attention and knowledge on the part of the engineers. But there is the other phase of the mechanical engineering of which the road engineer of today must have more than a passing knowledge. He must know the various principles of operation and control of motor transport of all kinds, from the touring motor car to the freight lorry, and their effect upon his roads in all seasons. He must also keep up with the activities of the manufacturers of today—with the rapidly changing types of steam, oil and electric vehicles.

The co-ordination necessary for electrical work in connection with streets and highways has already been indicated as to line crossings but it is no small matter in congested areas to deal with the complicated problems of electrical conduits in the roadbed, overhead wires, electric lighting arrangements and the vexing questions of electric railways and their maintenance with regard to the roadbed.

So with the chemical side of the work: There must be for the future a larger proportion of these engineers with a knowledge of the chemical properties of the various soils and materials of road construction and of the chemical processes involved in securing, preparing and applying in construction, the various special constituents of tar, asphalt and other materials.

Another feature, which in this new country is now very properly claiming attention in highway construction, is that concerned with the strategical planning of routes, either municipal or provincial, and the work of general design related to the broad principles of town planning. Much is to be made and is being made of this feature and it is very desirable that the coming engineering generation should make it a part of its work of preparation. In doing this they should not lost sight of the artistic and esthetic in their work of street arrangement and beautifying, in their boulevards and parkways, and even in the long reaches of rural highways which are so attractive a feature in the roads of England and France, of which the soldiers in the war have pleasant memories.

The Highway Engineer Must Be More Than a Technical Man.—But engineering and technical knowledge and experience are not all that the successful highway engineer of today and tomorrow will require. These will form only part of his professional equipment. He must be much more than a technical man. The nature of this work requires other knowledge and qualifications. He must have administrative ability; he must have vision, judgment and tact; and those most vital qualities which will enable him to deal with and co-operate with other men, whether workmen or employes, foremen or contractors, sales agents or walking delegates, business men, rate-payers or politicians. For after all, the business of the building and maintaining of highways today is largely business-administrative work with engineering closely mixed with it and as we go on in our complex methods of doing things the business and the engineering will become more interconnected and inseparable.

The highway engineer must, therefore, be an administrator, an economist and a co-operator with the business man, the legislator and the ratepayer. It is perhaps this part of his work which will make him the more valuable servant of the municipality or the state, but he will acquire that value only in so far as he can efficiently combine his engineering knowledge and experience with his administrative ablity.

Scientific Training a Large Factor in Successful Road Building.—Now how are we going to secure these engineers? It will be said that we ask for a super-engineer in this highly detailed specification of all he must be able to do. But why not? Is not our highway engineering going to be among the most important in the development of this country? We must then be prepared to meet the demand, and all those concerned in securing good engineers are equally responsible in the interests of good roads and highways.

The responsibility lies not so much on schools, colleges or universities as upon the municipalities and the governments that are building roads and highways. True, the colleges and universities must give the fundamental education, but it is quite evident that the further or later education must progress in successive stages in the field, on the actual construction or in the engineering or administrative offices of the highways departments or commissions of the country.

The place of the college or university in this educative process is however well defined and the work it is called upon to do is in a large measure common not only to all classes of engineers destined to be employed on highway work, but common as well to all sections of the country from coast to coast where this kind of work is being carried on.

The fundamental principles of applied science in respect to road building are the same everywhere, and colleges can deal with all of the underlying principles already outlined under the various civil, mechanical and other branches of engineering. It has been said that road building is an art rather than a science. That may have been true in the earlier days and even within our own memories, but it cannot apply today. The work that has been and is being carried out in the universities of Europe and America shows conclusively that scientific training is today a very large factor in successful road building. In the work of research the university has a special service to render to the state and it will be found that as time goes on and the problems of road building and maintenance and of road operation and traffic become more complicated the processes of experiment and research in which the universities can participate will be more than ever valuable to the road builder.

The universities must recognize that the education of the engineer of today does not stop at technical work. They must supply the engineering student as well with some of the economical, financial and broader education which at least will fit him to carry on after he gets out into his life work.

Advice for the Young Graduate.—When the young graduate leaves his college he must not by any means think himself an engineer, much less a highway engineer. He has much practical experience to get. If he is desirous of following highway work it is not necessary that he plunge into it as soon as an opportunity offers. There is much advantage to himself and his subsequent employers if he can get some other co-ordinating experience, such as, for instance, railway work or general municipal work. Railway work is especially fitting for carrying on with highway work and we are now coming to learn that the engineering work of both is similar and equal in importance with the advantage lying with highway work for diversity. It is well to keep in mind that so far as the present is concerned, there are many college graduates and other young engineers who have had the advantage of war experience on highway work, in road building and maintenance in France and in motor transport and traffic operation there under difficult conditions.

But the duty of the state is larger than that of the university in this respect of education. All that the university can do is to provide the early fundamental scientific education and but a small portion of the special highway engineering training. The municipality and the state must do the rest if they are to secure the right type of useful highway engineers. They must be prepared to take the young university graduate, or the specially trained or partially scientifically educated school or college boy, and put him into their organizations in such a way that he will learn the other side of the work of the engineer. He must be given every opportunity to learn the practical, administrative and operative portions of the work in successive stages, and only by this means will the state produce for itself broadly educated highway engineers.

Types of Federal Aid Roads

Up to June 30, 1920, 2985 Federal aid road projects, involving a total of 29,319.3 miles of road, had been approved by the Secretary of Agriculture. The total cost of these projects is $384,916,819, of which $163,841,503 is Federal aid. In the June issue of Public Roads Mr. Thos. H. MacDonald, Chief Bureau of Public Roads, regarding the apportionment of the above sum to the various types of roads.

PROPORTIONS OF FEDERAL AID APPROVED FOR VARIOUS TYPES OF SURFACE.

	Per cent		Per cent
Earth	8	Low types	26
Sand-clay	3		
Gravel	15		
Waterbound macadam	2	Intermediate types	9
Waterbound macadam mat top	1		
Bituminous macadam	5		
Miscellaneous intermediate types	1		
Bituminous concrete	6	High types	60
Concrete	41		
Brick	6		
Miscellaneous high types	7		
Miscellaneous types	5		5

If the various types be divided into three classes, according to their relative wearing qualities under heavy traffic, it will be found that only 26 per cent of the Federal aid approved has been allotted to such roads as earth, sand-clay, gravel, and others which may be regarded as low types. About 9 per cent of the Federal money will be spent for such intermediate types as waterbound and bituminous macadam, and 60 per cent of all the Federal aid approved will go for such high types of construction as bituminous concrete, portland cement concrete, and brick.

The classification of the mileage of roads approved is somewhat different from the apportionment of the funds. Such a classification is shown in the following table:

CLASSIFICATION OF MILEAGE APPROVED BY TYPES.

	Per cent.		Per cent.
Earth	25	Low types	66
Sand-clay	11		
Gravel	30		
Waterbound macadam	1	Intermediate types	9
Waterbound macadam, mat-top	2		
Bituminous macadam	3		
Bituminous concrete	4	High types	23
Concrete	17		
Brick	2		
Miscellaneous			2

It will be noted that, in mileage, the low-type roads preponderate, though the amount of Federal aid allotted to their construction is only about one-quarter of the funds allotted for all types. The mileage of roads of intermediate type is only 9 per cent of the total mileage approved, and 23 per cent of the whole mileage is to be improved with the highest class of construction.

A large part of the mileage of low-type road which has been approved is in projects in sections of the country where the pioneering work required to open up new territory yet remains to be done. Earth, sand-clay, and gravel surfaces have also been approved in many instances for projects which it is intended at a later date to surface with a more durable material. Whatever money is expended upon such projects for grading and drainage, which represent the major work involved in them, is money well spent for permanent improvement. The slight loss which will be sustained from the depreciation of the surface is far less than the loss which would be sustained as a result of the failure of an expensive surface laid on a new fill.

Movies Are to Boost Missouri Good Roads. The pulling power of the motion picture screen has been harnessed to the task of forwarding the road improvement program in Missouri. A one-reel film, telling the voters all about highway construction now under way and the good roads program for the future, has just been produced for the Missouri State Highway Department by the Rothacker Film Co. of Chicago. This picture will be shown in movie theaters throughout the state between now and election when road improvement bonds are to be voted on. The film shows many of the Missouri road improvement now under way, including those near St. Louis, Kansas City, Springfield, St. Joseph, Joplin, Sedalia and Fulton. The Rothacker camera man visited these counties: Cole, Jefferson, Callaway, Pettis, Clay, Vernon, Jasper, Christian, Lawrence, Mississippi and Scott. In the picture voters learn that the Missouri State Highway Department has laid out a 6,000-mile system with two state roads in each county connecting with state roads in adjoining counties, of which 1,075 miles had been surveyed Aug. 1.

Snow Plow for Town and Country Roads

A snow plow designed to cut a one way trail or a wide open highway sufficient to let trucks and automobiles pass each other is illustrated. This plow is built of selected Wisconsin white oak, secured by heavy forgings and castings. All runners and plow boards are bound with highly tempered steel. The deck is 8 ft. in width and the length over all is 16 ft. The sidewings are adjustable and will plow a road from 8 to 18 ft. wide. The depth of cut of the center plow is regulated by hand wheels. The plow is operated by either teams or by tractor. Hitches are provided for four teams, and as many more can be added as needed. The plow is known as the Phoenix. It is made by the Phoenix Manufacturing Co., Eau Claire, Wis.

Phoenix Snow Plow Being Operated by Two Men and Tractor.

Books on Engineering as a Profession

The following list of books and papers has been compiled by Engineering Council in response to requests, especially from parents and vocational advisers of high school boys, for information concerning the principal branches of engineering, the education and training requisite therefor, and the possibilities for making a livelihood therein.

Engineering as a Career.—Edited by F. H. Newell and C. E. Drayer; D. VanNostrand Co. 1916. (A collection of papers originally published in the "Cleveland Plain Dealer" and the "Scientific American" on various phases of engineering work)

Opportunities in Engineering.—Charles M. Horton. Harper & Bros. 1920.

Engineering as a Vocation. Ernest McCullough. David Williams Co. 1911. (Subject matter based upon a series of addresses given before technical schools and associations of engineer assistants; published for information of parents.)

Engineering as a Career. Percival and A. A. Marshall. P. Marshall & Co., London. 1916.

Addresses to Engineering Students.—Edited and published by Waddell & Harrington, Consulting Engineers, Kansas City, Mo.; 2nd edition. 1912. (Purpose of book is to give engineering students a broad conception of the profession.)

Engineering as a Profession.—Milo S. Ketchum. Bulletin of University of Colorado. 1916. No. 6. General Series No. 98.

Engineering as a Profession.—Dean William G. Raymond. University of Iowa. University Extension Bulletin No. 3. New Series No. 73. April 11, 1914.

A. N. Johnson Now Dean of College of Engineering of University of Maryland

Linking up of its engineering work with the Maryland State Roads Commission and with the U. S. Bureau of Public Roads, and the appointment of A. N. Johnson to be Dean, are the first steps in the reorganization of the Engineering College and the strengthening of the general engineering work of the University of Maryland. An arrangement was recently completed with the State Roads Commission and the Bureau of Public Roads whereby an engineering experiment station will be established here and run in connection with the Engineering College, under the direction of the new dean. The new arrangement was effected after a series of conferences between John N. Mackall, Chairman State Roads Commission, H. M. McDonald, Chief of Road Work for the U. S. Government, and Dr. A. F. Woods, President of the University of Maryland. The new arrangement went into effect Oct. 1 at which time Mr. Johnson assumed his duties as Dean of the College of Engineering and Director of the Engineering Experiment Station.

Mr. Johnson comes to Maryland with a full knowledge of Maryland conditions and with a reputation of being one of the best civil engineers in the United States. A graduate of Harvard, Mr. Johnson began his career as a member of the faculty of that institution. Since 1897 when he became a member of the National Highway Commission he has been concerned directly with practical engineering projects. From 1898-1904 he was State Highway Engineer of Maryland; in 1905 became Chief Engineer, U. S. Office of Public Roads; from 1906-1914 was State Highway Engineer of Illinois; and in 1915 was Highway Engineer, Bureau of Municipal Research, New York, and since 1916 has been Consulting Highway Engineer of the Portland Cement Association with offices in Chicago and Washington.

Mr. Johnson is given a free hand in the development of the engineering work at the university. Special emphasis is to be placed on general civil engineering and on highway engineering and its specialties. Broad development of the electrical engineering work along lines of electrical communication is intended. While great emphasis is to be placed on these lines, it is not the intention to neglect the other engineering work.

Definite Nomenclature for Pavement Types

As a matter of correctness and conciseness and to avoid needless controversies and legal actions, highway officials and writers of technical or popular articles and specifications should so designate a pavement type by name as to leave no doubt as to its nature. There is a tendency toward laxity in this regard in the haphazard use of the word "concrete."

The definition for "concrete" as given by the Century Dictionary reads: "A compact mass of sand, gravel, coarse pebbles, or stone chippings cemented together by hydraulic or other mortar, or by asphalt or refuse tar." This agrees with the definition as established by court decisions which has held in bond issue cases that the term includes mixtures cemented by either portland cement, natural cement, asphalt or tar.

It is then a matter of more than individual preference that Portland cement concrete pavements or bases and asphaltic concrete wearing surfaces or bases be referred to as portland cement concrete or asphaltic concrete when these are intended. To do otherwise leads to a misconception and may lead to disputes terminating in the courts.

Personals

Lloyd Aldrich has resigned as county engineer of Sonoma county, California.

McClain Mitchell, superintendent of public improvements of Paducah, Ky., has been appointed city engineer.

Ralph R. Arnold, county engineer of Contra Costa county, California, has been appointed county highway engineer.

Vaughn Watkins, of Jackson, Miss., has been appointed state highway commissioner of Mississippi, vice W. T. Pate, resigned.

M. O. Bennett, engineer of the Oregon State Highway Department, has left for Lewistown, Mont., where he will start farming on a large scale.

Donald M. Hepburn, for a time chief of the Bureau of Street Cleaning in Philadelphia, has resigned as chief of construction of the Pennsylvania State Highway Department to take a position in New York State. Alfred H. Sauerbun has been named to succeed him.

W. H. Sacket, formerly with the engineering staff of the Wisconsin State Highway Commission, has accepted a position with the Forest Products laboratory.

K. J. Eisenhardt, formerly resident engineer with the Indiana State Highway Commission, and P. P. Conkey, formerly County Engineer Tama County, Ia., have established offices at Evansville, Ind., and will conduct a general consulting practice in highway, mining and drainage engineering.

Ralph Modjeski, of Chicago and New York; George S. Webster, Chief of the Bureau of Surveys, Philadelphia; and Lawrence A. Ball, Orange, N. J., have been appointed by the Pennsylvania and New Jersey Joint Bridge Commission as the engineering board authorized to have charge of the construction of the Delaware River bridge between Philadelphia and Camden. According to an agreement between the Pennsylvania and New Jersey commissions, one engineer was to be chosen from each state and a third from a neutral state.

Obituaries

George W. Cooley, for many years state engineer of Minnesota, died last month. Mr. Cooley came to Minnesota in 1864 and entered the employ of the St. Paul & Pacific Ry. He later went on the United States surveys in Western Minnesota and North Dakota. He was employed by the Northern Pacific Ry. as the first location and construction engineer on that system. He conducted a general engineering office in Minneapolis, and in 1897 was elected county surveyor of Hennepin county, being re-elected for three succeeding terms. He resigned in 1906 to become state engineer.

Richard L. O'Donnel, vice president of the Pennsylvania system, in charge of the central region, with headquarters at Pittsburgh, died Sept. 28. Mr. O'Donnel was born in Philadelphia on Nov. 5, 1860. After being graduated from the Philadelphia High School in 1877 and the Polytechnic College of Pennsylvania in 1882, he entered the service of the Cornwall and Lebanon R. R. as a rodman. The following year, in 1883, he was employed by the Pennsylvania R. R. Co. as rodman, transitman and levelman in the construction department. In February, 1897, Mr. O'Donnel was promoted to assistant superintendent of the Pittsburgh division, and to superintendent of the same division on Jan. 1, 1902. He was appointed general superintendent of the Buffalo & Allegheny Valley division on Jan. 1, 1903, and on March 3, 1911, general superintendent, Western Pennsylvania division. On Aug. 20, 1917, Mr. O'Donnel was appointed assistant general manager of the lines east of Pittsburgh, and on July 1, 1918, he was advanced to general manager, continuing in that position under federal control. Mr. O'Donnel was advanced to vice president and placed in charge of the central region on March 1, 1920, when the lines of the Pennsylvania system were divided into four operating regions.

Industrial Notes

The 1920 assembly of the selling organization of Smith & Sons Mfg. Co., Kansas City, Mo., was held Sept. 28, 29 and 30 at Kansas City.

J. W. Gardner, President, The Gardner Governor Co., Quincy, Ill., has been named national councillor of the Hydraulic Society, to represent it in the Chamber of Commerce of the United States.

A convention of the Division Sales Managers of the Service Motor Truck Co. was held at Wabash, Ind., on Sept. 17 and 18. Sales managers representing every division of the United States were present.

"The Management and Organization of an Ideal Advertising Department" was the subject discussed at the September 14 meeting of the Engineering Advertisers' Association of Chicago, at which time Mr. R. G. Schaeffer, advertising manager of Marshall Field & Co., told of the large, efficient department he has in charge. Mr. Schaeffer explained how the various departments and bureaus coordinate their work to meet plans approved by the general advertising department. At its October meeting the Engineering Advertisers' Association will discuss market analyses and sources of advertising data.

Announcement is made by the American Steam Conveyor Corporation of a change in its corporate name to the "Conveyors Corporation of America." The change in name is due to the rapid growth of the corporation, the addition of new lines of business and the purchase at South Bend, Ind., of a large and completely equipped machine shop to which foundry facilities will be added. The new name more nearly describes the present business of the organization. Its line includes steam jet conveyors for handling ashes, soot, combustion ash, etc.; trolley carriers for handling coal, limestone, sand, gravel, and like loose bulky materials; ash pit doors; flood oil bearing sheaves and other conveyor supplies. There is no change either in the personnel or policy of the company.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Road Rollers.—Buffalo-Springfield Roller Co., Springfield, O. 12-page circular on the Buffalo-Springfield tandem steam rollers.

Road Rollers.—Buffalo Steam Roller Co., Buffalo, N. Y. 34-page catalog illustrating and describing the Buffalo Pitts Rollers.

Motor Trucks.—Kalamazoo Motors Corporation, Kalamazoo, Mich. 16-page catalog illustrating and describing the truck manufactured by the above company.

Snow Plows.—The Good Roads Machinery Co., Inc., 821 Bulletin Bldg., Philadelphia, Pa. 16-page bulletin illustrating and describing the Champion snow plow and the methods of using it.

Trailers.—Troy Wagon Works Co., Troy, O. 32-page catalog containing specifications of the various models of Troy Trailers. Illustrations of some of the uses of these trailers also are given.

Tractors.—The C. L. Best Gas Traction Co., San Leandro, Calif. 20-page catalog devoted to the "Sixty" track layer tractor of this company. Contains illustrations and descriptions of the units of this machine, and its specifications.

Self Feeding Bucket Loaders.—Barber-Greene Co., Aurora, Ill. 32-page catalog illustrating and describing the B-G line of material handling machines. Numerous illustrations are included showing the uses of the loaders in road construction.

Tractors.—J. T. Tractor Co., Cleveland, O. 26-page catalog giving a presentation of the principles of tractor design, construction and operation. Contains specifications of J. T. Tractor and illustrations and descriptions of its use in road making and other work.

Steam Shovels.—Ball Engine Co., Erie, Pa. 24-page bulletin describing standard "B" and high lift "B" types of Erie shovels. Contains chapters on street and road grading, rock work, cellar excavating, locomotive crane service, trench digging, etc.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 403 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 415 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00; any one monthly issue 50c. Extra foreign postage, all issues $4.00; any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., OCTOBER 13, 1920. Number 15.

"Stop This Talk of Underproduction by Labor."

Newcomb Carlton, president of the Western Union Telegraph Co., recently said:

> The time has come for people who ought to know better to stop this talk of underproduction and of labor slacking on the job. Labor is the backbone of the country today, and in America is setting the rest of the nation an example of patience and earnestness and loyalty.
>
> There may be slackers here and there, but our average workingman is sound to the core, and can be depended upon a great deal better than some of those who take it upon themselves to criticize him.
>
> In the face of higher prices, which in many cases have wiped out wage increases, in spite of discouragements and disappointments of various sorts, in spite of prohibition which many of them bitterly opposed, American workingmen are keeping right on the job and are giving the best that is in them to their work today. This is the conclusion that I have reached at the end of a 10,000-mile trip through the country which I have just finished.

Important as such an inference of an employer of 46,000 people may be, when the inference is based on data secured during a nation-wide trip, there are available even more convincing facts than such as Mr. Carlton cites. For example, there are statistics in Price Bulletin No. 1 of the War Industries Board which completely refute the prevalent idea that underproduction has been one of the main causes of high prices. The following table is from page 45 of that bulletin and shows the aggregate value of "90 raw materials, including substantially all the great staples," the annual quantities of which were priced out for each year, at the average wholesale prices that existed in 1917:

Year.	Aggregate value
1913	$30,277,000,000
1914	30,297,000,000
1915	32,482,000,000
1916	33,700,000,000
1917	34,748,000,000
1918	35,169,000,000

Note particularly that by using the same unit prices for each year, the total "value" of the 90 staples in 1918 is comparable with that of 1913, because the effect of price changes is eliminated. We see that in five years the production of the 90 staples increased more than 16 per cent, or twice as rapidly as population increased during that period.

The productivity data given in an editorial in our issue of May 12 are in substantial accord with those just quoted. We there showed that our combined crop and mineral output for 1919 was only 2 per cent below that for 1918, and 11 per cent above that of 1913.

Babson's Statistical Organization gives the following information in a recent "Barometer Letter".

Year.	Production index figure.
1913	100
1914	100
1915	105
1916	108
1917	110
1918	115
1919	109
1920 (6 mos.)	110

The subjects on which Babson's production index are based are: Cotton, petroleum, wheat, corn, pig iron, copper, coal and live stock. These are the leading raw materials (except lumber) used in manufacturing, so that it is safe to gage manufacturing productivity by them.

In Mr. Gillette's 20-page article on the causes of high prices (Apr. 7 issue), data on production were given and analyzed in great detail; and in his article in our May 5 issue on the Effect of Exports on Prices, it was shown that during the years 1915 to 1919 inclusive only 10 of our commodities were exported in excess of our imports, the pre-war average excess being 2.5 per cent, from which it was made clear that foreign demand upon us for commodities did not account for the enormous rise in commodity prices.

Mr. Carlton is certainly right in his appeal to the public press to cease talking of general under-production, for it does not exist. There has undoubtedly been some shirking of duty on the part of workmen, particularly in the construction field, but this is rapidly vanishing. A rapid shrinkage in average commodity prices is occurring, but it will probably cease before spring. Every month shows marked improvement in freight transportation. All in all, there is a splendid outlook for a big construction season in 1921.

How to Improve the Memory.

By HALBERT P. GILLETTE, Editor.

Led by William James, modern psychologists have been asserting that memory can not be strengthened by exercise, like a muscle, but remains substantially unchanged in its power. They point out, however, that the more facts of a given class that a man memorizes the easier it becomes for him to retain new facts of the same class. Thus a person who studies faces with the purpose of remembering them, steadily improves his ability to remember new faces, until he may acquire an astonishing ability to recall any face that he has once seen attentively. The same person, however, may have a very poor memory for names, or for numbers, or for any of the thousands of classes of things that have not been particularly interesting to him.

It has yet to be proved that the exercise of certain parts of the brain does not strengthen those parts, much as a muscle is strengthened. In fact, it is well known that animals having highly developed senses have correspondingly large brain areas that receive the sensations.

Be the fact as it may, it is certain that the development of a good memory for one class of facts is largely the result of practice in remembering facts of that class, and to this extent is like the strengthening of a given muscle by exercising that particular muscle.

In training a memory for a given class of facts, the most important initial step is to arouse keen interest in that class of facts. Interest in things exists where pleasure or profit (which latter is an order on future pleasure) is associated therewith. Show an engineering student exactly how he is going to profit from the study of calculus, and you have probably made the formulas for differentiation and integration more interesting to him. Show him wherein he will profit ultimately from a command of the English language, and he will remember more readily the rules of grammar and the distinctions between synonyms. Show him that a study of logic will make him less likely to err in his reasoning, and you will find him stronger in his ability to retain the rules of logic.

A good memory unaided by the ability to analyze and synthesize the things remembered may not be, and usually is not, very profitable. On the other hand, analytical and synthetic abilities are badly handicapped without a brain well stored with facts. Failure to understand this principle accounts for much of the ill-advised ridicule of any teaching that is primarily a training in memorizing facts. For example, spelling has almost become a lost art, because teachers have been inclined of late to ridicule mere memory drills. The old "spelling bee" has gone out of fashion, yet it was an admirable device for arousing interest in a dull subject, and therefore for strengthening the ability to remember the arrangement of letters in words.

Prof. Joseph French Johnson, Dean of the New York University School of Commerce, recently said:

> The reader must bear in mind that memory is not a separate faculty of the mind, as the arm is a single member of the body. The memory is the whole mind recalling a past state of consciousness and recognizing the fact that it was one actually experienced. Logically those experiences which made the deepest impression on you will be the ones you will think most about and will recall most easily. It follows, therefore, if you wish to have what is called a good memory, that you must really be interested in the things which you wish to recall.
>
> The first essential therefore, to a good memory is a mind alive, wideawake, interested in something. A baseball fan, although a dunce at school, unable to master fractions or to remember four important dates in his country's history, can be relied upon to tell you the batting averages of most of the players of the two major leagues. So an educated chauffeur who cannot be trusted with errands because of his poor memory, will recognize every car he passes on the road and tell you the peculiarities of its gear shifts, etc.
>
> So let us formulate the first law of memory: The power of memory increases directly in proportion to the mind's' interest in its own states of consciousness; that is to say, the mind recalls most readily those states of consciousness to which it has given closest attention and in which it is most interested.
>
> We remember things that interest and please us because we like to reproduce their image in our consciousness and this repetition, if repeated often enough, makes them an unforgettable part of our memory stock.

This, in the main, is true; but it is exceedingly doubtful whether, "The memory is the whole mind recalling a past state of consciousness and recognizing the fact that it was once actually experienced." If this is so, why is it that the mind is so stubborn in its refusal to recall certain classes of facts and so willing to recall certain other classes? It is much more probable that certain minute parts of the brain undergo a change (perhaps a chemical change) whenever a new combination of sense impressions is conveyed thereto, thus producing sense-records. These sense-records would thus be analogous to photographs, and if so, would not cover the whole brain but only very minute parts of it. These minute parts of one sense-record, however, might not all be in one small section of the brain, but widely separated. It certainly leads to a definite conception as to what memory is when we regard it as consisting of sense-records, analogous to photographs or to phonographic records; whereas to speak of "the whole mind recalling a past state of consciousness" gives us no definite picture of the act of remembering. Indeed such an explanation is no explanation when carefully analyzed, and it merely lulls us to sleep in ignorance of what the mechanism of memory is.

In his "Psychology" William James says:

> Of two men with the same outward experience and the same amount of mere native tenacity, the one who thinks over his experiences the most and weaves them into systematic relations with each other will be the one with the best memory.

This is equivalent to saying that a man improves his memory of things by making his own analysis and classification of them. It is often better to devise a classification of your own, differing considerably from that that your book or instructor has given you. Hence comes the memory value of writing an original article or book, even if the originality be entirely confined to the new grouping of the facts in systematic fashion.

Nearly every writer on logic dwells upon the value of words as aids to the memory of things experienced. Some go so far as to assert that without suitable words for experiences, we would remember relatively few things. At any rate, it is undeniable that a good memory for complex things and events is usually associated with a good vocabulary, expressive of them. Moreover, it is worthy of note that whoever has practiced writing his own definitions of terms has gained not merely in clarity of conception of, but in ability to remember, the things that the words symbolize.

It is universally admitted that memory of things is strengthened by repetition, whether the repetition be that of re-experiencing the thing or of repeating the words that symbolize it. Yet relatively few men take the pains to rehearse the experiences of each day with a view to remembering them. It is practicable to call to view most of the faces of people whom we have met, and to repeat aloud their names, together with some words expressive of their character and appearance. Were this done systematically, few of us would ever complain of inability to remember names or faces. The same holds as to what we have heard or read during the day. Nearly all that is apt to be worth while can be retained for a long time if we merely repeat it to ourselves before the night's sleep has wiped our mental slate clean.

Close attention, repetition, association of each fact with other facts, and the acquirement of a suitable vocabulary whose terms have all been carefully defined by yourself, are four of the greatest aids in developing a good memory for any class of facts.

A good memory should not be despised because possessors of such a memory have not used it to advantage. With as much reason might our pioneer forefathers have belittled the worth of the rich acres of the Mississippi Valley because the Indians had put them to so little use.

Annual Meeting of City Managers' Association.—The 7th annual meeting the City Managers' Association will be held in Cincinnati, Nov. 15 to 17. The Hotel Sinton has been chosen as convention headquarters. National authorities are to be invited to present the latest information on practical problems with which city managers must deal. The National Municipal League will not meet at Cincinnati, as had been anticipated, but will convene at Indianapolis Nov. 17 to 19. One of the sessions at the meeting of the league will be devoted to the city manager movement.

Book Review

Hydraulic Tables.—By Gardner S. W[illegible] Civil Engineer, formerly [illegible] itary Engineering, University of [illegible] M. Am. Soc. C. E. [illegible] New York: John Wiley & Sons [illegible] Ltd. Ill., pp. 115, cloth, 6x9 in. [illegible]

This new edition of an already [illegible] has few changes from the preceding edition. [illegible] is a chapter entitled, "Additional [illegible] [illegible] and briefly discussed the results of [illegible] investigations made since the last edition. These results in general confirm the authors' earlier results in a satisfactory manner.

Briefly, the tables in the book are divided into two main sections, namely, those showing the flow of water in pipes and other passages, as computed by the Hazen-Williams formula, and those showing the flow of water over weirs of different types. No changes, except for minor corrections, have been made in these tables from the previous edition. In the tables which show the loss of head in various sizes of cast iron pipe it might not have been amiss to have included data for a few of the odd sizes as, for example, 14-in. and 18-in., because a considerable amount of this pipe is now used. The value of this work, however, cannot be underestimated.

Design Features of Inverts for Winnipeg Aqueduct

In the design of inverts for the Winnipeg water supply aqueduct, soil conditions were encountered which made it necessary to consider the effect of a variability in the bearing power of the same soil under different loads. A description of tests made and types of inverts finally used was presented in a paper by James H. Fuertes, Consulting Engineer, New York City, at the Montreal Convention of the American Waterworks Association, and the following abstract of this paper may be of interest.

A large percentage of the total length was of boulder clay, hardpan gravel and rock, or of soft soil on top of solid materials. The first 20 miles, however, was through a prairie country, the soil of which was clay deposited from [illegible] water ages ago, and practically devoid of silt or granular materials. The clay is underlaid with a layer of gravel and boulders resting on the limestone rock some 10 ft or more below the surface.

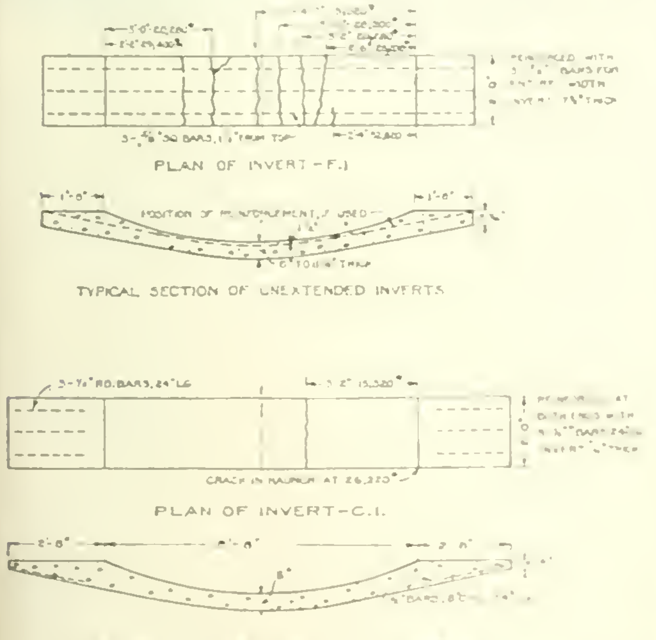

PLAN OF INVERT-F.1
TYPICAL SECTION OF UNEXTENDED INVERTS
PLAN OF INVERT-C.1.
CRACK IN HAUNCH AT 26,375
SECTION OF EXTENDED INVERTS-C.1 AND C.2

Fig. 1.—Typical Test Inverts

The soil is very peculiar and uncertain in its action under loads, and many serious structural accidents have occurred in Winnipeg and vicinity as a result. Its compressibility is variable, depending on its depth below the surface and on its water content. Under a constant load, there is a con[illegible] progressive settlement and a greater [illegible] settlement in small than in greater depths [illegible] the natural surface of the ground.

This variability in compressibility [illegible] conditions which made it impossible to [illegible] [illegible] that would be free from [illegible] trouble. No [illegible] however appeared in the aqueduct [illegible] invert or arch except under the [illegible] [illegible] of [illegible] water [illegible] with [illegible] of 2 ft or less. These conditions were [illegible] and fully weighed before proceeding with the design and construction of the inverts.

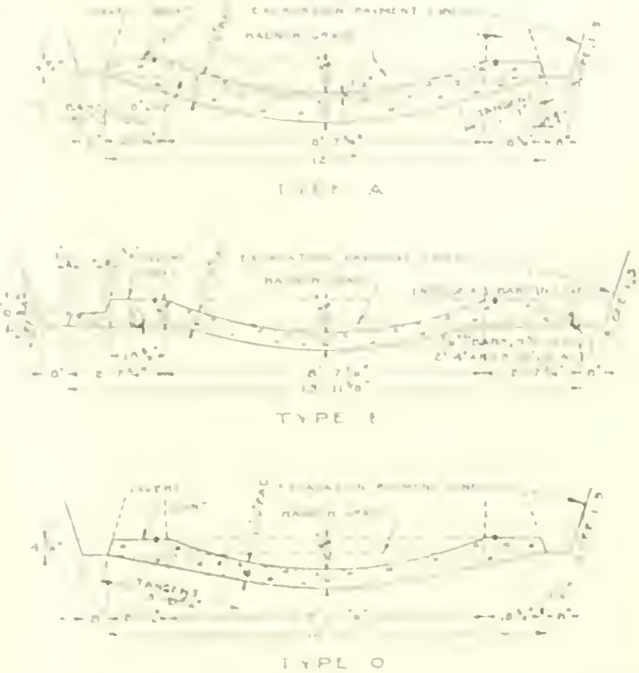


Fig. 2—Final Standard Types of Inverts

As a matter of fact, out of a total of 75 miles of work practically all of which was done in 1915, troubles from settlement occurred in only about 2.5 miles.

None of the work referred to as cracked was taken out or replaced. Most of it was repaired by cutting out the cracks to a width of about ½ in. for a depth of 2 in. and packing the cracks with hammer-caulked neat Portland cement, put in very dry and tamped very solidly, first washing all loose chips, sand and dust out of the prepared cracks with water under pressure.

To test the tightness of the aqueduct after repair, a number of sections were selected and tested, one of these, 270 ft long, was purposely picked out to include the most seriously damaged portion. In this section the invert had several longitudinal cracks, some open ½ in. at the surface, others of smaller widths, and the arch was cracked along the haunch on one side as well as along the top. Bulkheads were built at each end of the section, which was then filled with water to the level corresponding to a rate of discharge of 85,000,000 gal. per day. Daily records were kept of the drop in water level for some months and the rate of leakage found to be less than 5,000 gal. per mile of aqueduct per day, which for this size of aqueduct, equivalent to a circle 8.1 ft diameter, would hardly be called excessive for a cast iron pipe line with caulked joints. The average of the other tests gave a leakage of about one-third of that amount.

The actual cost of the repairs of the 5,200 ft repaired, including labor, materials and incidentals, was less than 50 ct per foot of aqueduct repaired; in fact, about $2,500 in all.

With the greater experience gained both by the engineers and inspectors, and by the contractors' men, in securing more thoroughly compacted foundations, particularly along the sides of the inverts, practically all invert cracks could have been eliminated in future work without the use of heavy reinforced inverts.

The standard invert, used throughout, during the 1915 construction program, and until April, 1916, was, in form, a concrete slab as wide as the extreme spread of the feet of the arch from outside to outside, with a curved upper surface, struck to a radius of 14 ft for the aqueduct 9 ft high (the largest size used) and 8 ft. 1¼ in. for the aqueduct 5 ft. 4¾ in. high (the smallest size used). The slab was 6 in. thick in the center and for a certain distance each side, then built on a uniform flat slope to the full width required, and was laid in 15-ft. lengths, with crimped copper expansion joints between each slab, in advance of, and to form a footing, for, the arches.

During the first year's work it was next to impossible to get the contractors' men to properly consolidate the foundation along the edges of the trench, particularly where the soil was of clay, the temptation being so strong to trim the surface to the exact grade required with sharp shovels, which cut it like cheese and left a fine surface for the concrete. This operation, however, left the top surface uncompacted, and capable of considerable compression under moderate loads, and a large percentage of the fine cracks in the invert were due to this fact. Finally it was required that all compressible clay subgrades, particularly in shallow cuts, and where the trench was moist, or wet, should be covered with a thin layer of gravel, to be heavily hand-rammed for a width of about 3 or 4 ft. along the outside edges.

When it is realized that a deflection of only about 1/30 in. would cause cracks in the inverts, the reason for a hair line crack along the center of the invert, when the back fill was put over the arch is easily understood, where the subgrade was simply trimmed with a shovel.

The uncompacted soil would at times exhibit that much compression under loads of only 700 lb. per square foot, or about 5 lb. per square inch. Rolling these subgrades, even under planks on a gravel bed, was impracticable; it would jelly below the surface and work into waves ahead of the roller; hand compacting by heavy rammers on a thin bed of gravel seemed to be the best means of getting hard enough bottom.

In order to have something more than theory as a guide as to the actual distribution of pressure over the bottom of the aqueduct, to aid in proportioning the inverts for this condition of soil, a series of full-size inverts for the 8 ft. 9 in. by 7 ft. 4⅝ in. aqueduct, made 2 ft. in width and laid parallel to each other on the natural soil trimmed to shape, was built. There were in all 16 inverts, as follows:

A1, A2 and A3. Standard inverts 6 in. thick in the middle as used in all aqueducts prior to April, 1916.

B. Standard invert with 3 wood strips, ⅝ by 1½ by 24 in. built across the invert in the center and near the ends, where cracking had occurred in the construction work.

C1 and C2. Standard inverts 6 in. thick at center with 12-in. extension on each end, making the out-to-out width 14 ft. instead of 12 ft. as in the original inverts for this size of aqueduct.

D1 and D2. Standard inverts 6 in. thick reinforced with ½-in. round bars 8 in. c. to c.

E1 and E2. Standard inverts 6 in. thick reinforced with ⅝-in. square bars 8 in. c. to c.

F1 and F2. Standard inverts 7½ in. thick reinforced with ⅝ in. square bars 8 in. c. to c.

G1 and G2. Invert of standard width, but 10 in. thick, reinforced with ⅝-in. square bars 8 in. c. to c.

H. Invert of standard width, but 11¼ in. thick, reinforced with ⅝ in. square bars 4 in. c. to c.

K. Standard invert 6 in. thick reinforced with ⅝-in. square bars 4 in. c. to c.

These inverts were built in the regular way and were provided with concrete pedestals about 2 ft. high on each side, of the width of the sides of the arches. The loading was done by laying 60-lb. steel rails across the top of the two pedestals and observing the settlement of the invert at each side, at the middle and at the quarter points, as the load was increased. The deflections, or settlement, as reported, were measured with accuracy below a fine bronze wire stretched tightly across from posts driven deeply into the ground on each side of each test invert.

The load, and deflection at each point, was recorded as each crack appeared, and from these records a number of important deductions were evident. For instance, in inverts C1 and C2 (see Fig. 1) cracks did not appear until the load carried was as great as that required to produce the first cracks in inverts F1 and F2, which were 1½ in. thicker than C1 and C2; and in addition were reinforced with ⅝-in. square bars 8 in. center to center. In fact, these two thin, unreinforced inverts carried a greater load without a crack, than any other, except those which were heavily reinforced and nearly twice as thick. There was, however, this important difference, that by the time the test load had reached an amount equivalent to the actual load due to the aqueduct and its backfill and water load, a little over 5,000 lb. per side per foot, the inverts C1 and C2 had shown but one crack each in the center, which load had to be increased by 50 per cent to cause the second crack to appear at the edge of the invert in each case.

Reinforced inverts D1, D2, E1, E2, F1 and F2, showed from 2 to 6 cracks under the same loading as C1 and C2; and even G1, G2 and K showed 2 to 5 cracks across the surface before the load reached the amount normally to be carried by the arch. In other words the only reinforced invert that demonstrated its superiority to plain thin inverts C1 and C2 with an extended base was invert H, which was twice as thick (11¼ in.) and also reinforced with ⅝-in. square bars 4 in. c. to c. Furthermore, the cracks in inverts C1 and C2 could be repaired and the results be made as good as the originals, while the reinforced inverts could not be repaired except at much greater cost, owing to the multiplicity of cracks, and at the risk of further disintegration if acid soil water should penetrate to the steel from below.

The appearance of two characteristic inverts, showing the location of the cracks and the loads under which they occurred is indicated in Fig. 1.

To prevent further cracks in the invert, a change was made, early in 1916, by adopting for all solid ground, regardless of whether it were compressible or not, a standard invert 6 in. thick at the center with an 8-in. extension on each side beyond the standard invert, and for all questionable foundations, inverts varying from 8¼ to 11½ in. in thickness, reinforced with ⅝-in. bars from 4 to 5¾ in., center to center, according to the size of the section. After the tests above referred to were completed, and others, also, along different lines, a more conservative program was adopted.

Three types of invert were designed, to cover the range of variability in foundations, and, after 1916, construction has been in accordance with them. Type A was for compressible soils; type E for poorer than best but better than worst foundations, and type O for solid foundations. The invert adopted for solid foundations was the original design used throughout 1916. For the poorer than best foundations the standard invert of 1915, extended 8 in. on each side, was used. For the compressible foundations the inverts were the standard inverts of 1915 thickened from 6 in. to from 7½ in. to 12¼ in., and reinforced with ⅝-in. bars from 7½ to 9 in. c. to c., according to the size of the section. This policy resulted in a considerable saving over the extravagant policy of 1916. The general designs for these three types, for the "B" section of the aqueduct (8 ft. 9 in. by 7 ft. 4⅝ in.) are shown in Fig. 2.

One more condition respecting invert designs required consideration, and that was for use where the available backfill material was of light weight, the aqueduct submerged and the foundation soil porous, or more than a certain depth below grade, varying from 25 in. for the 8 ft. 9 in. by 7 ft. 4⅝ in section to 31 in. for the 10 ft. 9 in. by 9 ft. section. The problem here was to secure stability and permanence for the aqueduct, full and empty, when the ground water level was above the arch of the aqueduct and the backfill materials so soft, light and lacking in cohesive properties as to be of practically no value except for frost-proofing.

Many studies were made of plans to secure this result, such as gravel backfill, hauled from the districts pits by train, backfills placed by hand, and thin reinforced inverts covered with 2 or 3 ft. of packed graded gravel, and having a concrete paving over the gravel to form a smooth durable invert. The most economical and best plan consisted in placing under the reinforced 6-in. invert a thick foundation course of lean concrete monolithic with the invert. The lean mix consisted of 1 bag of cement to 16 cu. ft. of gravel, and its maximum thickness at the center was 19 in.

Rainfall in Hawaii. An inch a day is the average rainfall in the upper Walpio Valley, Hawaii, which makes it one of the areas in the world where the rainfall is heaviest. On the other hand, the rainfall on some of the slopes of Hualalai, on the same island, is only 20 in. a year. The only surface streams on the island are along the northeast coast between Hilo and Kohala. Waipio River, according to the U. S. Geological Survey, has been partly developed for irrigation.

Popularizing the Business of Selling Water

By R. E. M[illegible]

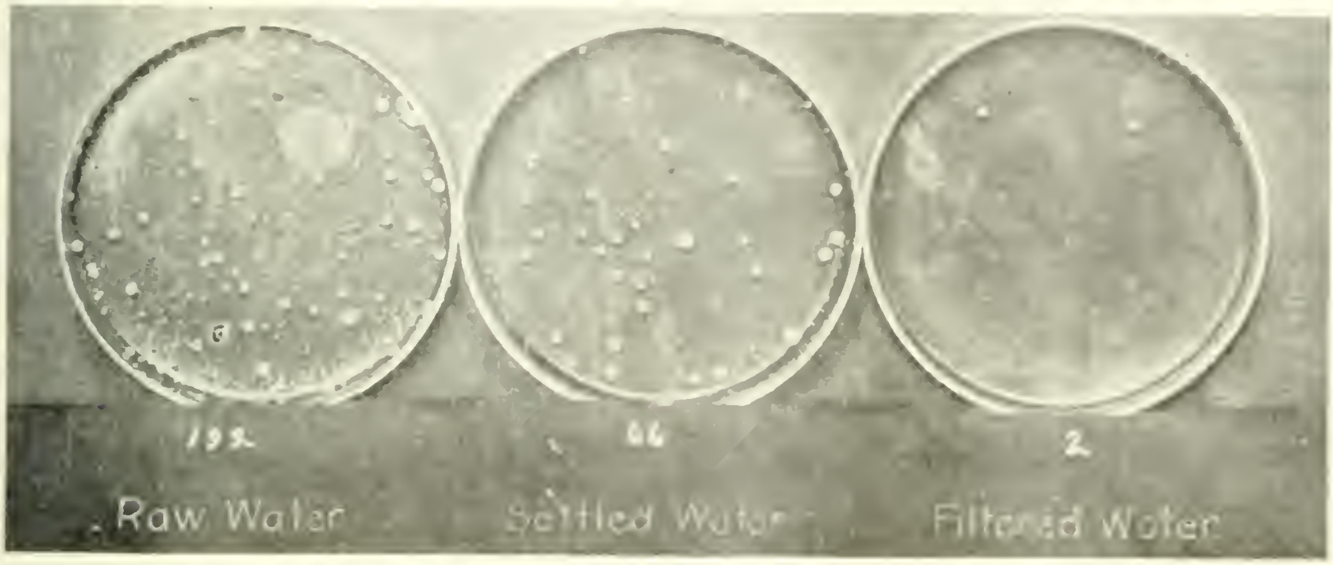
Of [illegible] & M[illegible]

The business of selling w[illegible] municipally owned plants, wit[illegible] a manner tending toward ban[illegible] toward profits and success, d[illegible] ure of the water works [illegible] conduct the waterworks with [illegible] customers must have the water [illegible] tice of ignoring the public [illegible] paying the penalty.

Just now, at a time when [illegible] terials and operating costs are [illegible] and increased rates must be [illegible] cials, whether private or mun[illegible] the public and conduct a camp[illegible] works facts and information be[illegible]

[illegible]

Passing by Prospective Customers.—[illegible] residence district seeking friends, they passed by many



Photographic Bacteria Plate Illustrating the Difference Between Raw Water and Purified Water.

public opinion. The facts about water, its purity, the plant and its condition are now given out in a defensive attitude and the lack of familiarity of the consumers with the plant and its needs show the need of keeping before the public an educational campaign of popularizing the water, light, gas, or other utility. This campaign of publicity would have been easier had it been conducted constantly rather than spasmodically in time of stress.

Public Clamor Against Utilities Due to Lack of Information.—A large proportion of public clamor against a utility is because the public is not posted as to the facts pertaining to the utility and its relation to the welfare of the citizens. The knowledge and impressions of the public regarding the waterworks matters are in most cases gained at the water collector's window and through the monthly or quarterly bills mailed out. I wonder how many of you here have ever compared the affability, courtesy, and patience displayed by the clerks selling water with that of the clerk selling dry goods.

Can you imagine a clerk in a dry goods store approaching a customer coatless and with a pipe in his mouth? Yet, at a water collector's window such a thing is not unusual.

Friends for a municipal water plant are just as important as for private enterprise, for on the attitude of these friends depends the character of improvements. Appeals to the public for funds must be constantly made, either new bond issues or tax levies are required in any growing community and the readiness with which the public responds to these appeals depends upon the friendly or unfriendly attitude toward the waterworks plant and its officials.

A waterworks official recently made the statement, 'We must have new filters, we need new pumps, and we need new mains, but most of all we must have higher rates, but it will be a hard job to convince the public of these necessi-

prospective friends or customers merely being too backward and modest to stop along the street long enough to make a connection which is always essential to cement good relations.

In one particular individual or plant a fourth of the people along the street were passed by with a scornful attitude of mind, saying, come to the office if you want to make my acquaintance. One waterworks individual who prided himself on the popularity of his management has discovered that out of 100.9 miles of mains there are 2,567 vacant lots, or 48 miles of his extensions front vacant property, all suitable for residences.

Every vacant lot passed is a direct loss, although it is a prospective customer whose acquaintance and connection is needed. Statistics show that for towns of the samo population some water plants have as low as 10 services per 100 people, while others as high as 27 services per 100 people. Out of a list of 31 cities in the Southwestern Waterworks Association territory it is found that the connections per mile run from 13 to 87, with an average of 50 per mile. If your own city shows less than this average, when you go homo try and find the remedy and if you bring it up to the average your municipality or company has made a good investment in sending you to this convention.

The Advantages of a Complete Program of Future Growth.—To revert back to the job of consulting physician to sick water plants, I find the growth of the plants like most young children, it all to legs and arms until it becomes awkward, with nothing but extensions and nobody to supply their wants, and in a few years the vital parts, such as supply pumps, reservoirs, etc., are behind the extensions. Then comes a breaking down of the system and a rehabilitation is necessary which is doubly hard because the public must be told how and why it happened and the sickness of the plant is often one that could be avoided by constantly watching its growth, acquainting the public with the symptoms of its illness and give a tonic in the prescription in the way of betterments before the patient goes to the hospital. This can best be accomplished by a complete program of future growth, showing what the plant will need in order to supply its growing condition.

---

*From a paper presented Sept. 20 at S[illegible] Association Convention.

Let this program of growth go before the public in every possible way so there will be no shocks or surprises. Your rate of consumption from year to year, your rate of extension of mains, your pump capacity requirements, in fact every feature of the plant can be compared in graphical diagrams and curves showing the plant's needs. Supply them as news items on folders accompanying bills, as cartoons, and on the receipted cards, as for example, Omaha never lets the public forget the saving resulting in the municipal ownership and operation of that plant, for the same rate charged under private ownership is still printed on the cards, and in red ink is printed the reduction in cost of water under municipal ownership.

Advertising Pure Water.—The most common ailment of waterworks plants is that produced by permitting impure water to go into the mains. Pure water is an asset that no city can afford to be without. If your city does not have pure water you are without the essential qualifications of ever making the plant a success.

After a pure water supply is established the publicity regarding its purity should always be kept before the public. The American Public Health Service has fixed a high standard and when a water plant meets their requirements and sells water for train service this fact should be made known.

Photographic bacteria plates illustrating the difference between the raw water and purified water, as shown in the the illustration, are always convincing and interesting to the public.

Milk companies of many cities have recently inaugurated advertising campaigns to popularize milk, giving cartoons showing beautiful and healthful children, attributing everything to pure milk. Their statistics are convincing. The U. S. Department of Agriculture popularize by cuts, drawings, pamphlets, and photographs, before farmers, the need of pure seeds. Pure water has more good sound arguments as a basis for advertising and popularizing it than any other commodity.

Increased Cost of Waterworks Materials and Water Rates.—At the Tulsa meeting of this association, nearly three years ago, my sanity was somewhat questioned when I predicted greatly increased prices in all water works materials as soon as the Government removed the war-time restrictions, and we have in the last five years experienced increases even greater than then predicted.

The following percentages of increase in the waterworks materials and labor is derived from figures from more than 100 water works officials in 36 states:

	Per cent.
Cast iron pipe increase	245
Special castings increase	191
Lead increase	88
Meters (¾-in.) increase	37
Valves (6-in.) increase	107
Coal increase	98
Average increase in superintendents' salaries	37
Average increase in other employees' salaries	57

The alarming feature of the investigation shows that 79 per cent of the 100 cities have received no raise of rates, yet practically all of the cities are in urgent need of an increase. Of the 21 per cent of the cities securing a raise of rates, the average increase has been 49 per cent.

The one fact preventing a uniform raise of rates to meet the corresponding increase in other commodities is the lack of knowledge that the public possesses regarding the needs of the plant, its true condition, its value in dollars as a basis of rates and as an asset to the community, which facts ought to be clearly set forth before the public and kept constantly before the public. If comparisons were made for use of the individual in the costs of all ordinary commodities, it would be found that water, although the most essential of all commodities, is the lowest in cost.

If you will compare your meat bill, bread bill, fuel bill, picture show bills, or cigar bill with your water bill you will find water the lowest of all.

Water needs popularizing both for the sake of our own health and happiness and for the future success of the waterworks business.

17 Rules for Boiler Plant Maintenance and Operation

Concise rules followed by the firemen of 28 coal firing boiler plants in the Middle West, with remarkably good results, are given as follows by E. H. Tenney, Chief Engineer of Power Plants of the Union Electric Light & Power Co., St. Louis, in a letter in a recent issue of the Electrical World:

1. Stop all air leaks in boiler settings and flue doors. Leaks can be very easily found with a lighted candle. Air should be admitted to a furnace through the fuel bed and at no other place.

2. Keep boiler tubes free from soot and scale, both inside and outside. Special attention should be given to the regular cleaning of flues and tubes.

3. Keep side walls and bridge walls free from ashes and clinkers; these retard the draft, cut down the available grate surface and cause a waste of fuel.

4. Keep ash pits cleaned out at all times; if they are full of ashes, not only is the draft retarded, but also the grate bars are burned out more quickly.

5. Experiment to determine the draft required to burn the fuel to the best advantage.

6. Fire little and often rather than a large amount less frequently. By such firing it is easier to prevent holes from forming in the fire and better fuel economy results. Holes appearing in the fuel bed should be immediately filled up with fresh coal.

7. Do not fire large lumps of coal. These should be broken up to the size of a man's fist before firing. Air holes form around a large lump, and it is also harder to spread an even fire with large lumps than with smaller pieces.

8. Use the poker or slice bar as little as possible to minimize carrying unburned coal down into the ash pit.

9. Watch the ashes after cleanout periods to determine whether all the coal is being consumed as well as it can be. A simple test for determining the presence of unburned fuel in ashes is to pour water over them; the ashes will be red and all unburned coal or coke will show itself immediately.

10. Use the damper as much as possible to control the fire and the steam pressure.

11. Keep the hand-fired grates or automatic stokers in repair at all times. Be sure the great bars are not warped and twisted out of shape, allowing coal to fall through into the ash pit. Be sure the fronts around stokers are not allowing excess air to go into the furnace over the fire.

12. Use draft gages on boilers. Determine the draft which gives the hottest fire and maintain it at all times.

13. Keep no more boilers on hot banks than are absolutely necessary to carry the load during a peak. Be sure that the boilers are banked in the most efficient manner.

14. Keep the steam leaks about the plant down to a minimum and give special attention to see that all small valves, drips, drains and traps are tight and not leaking live steam.

15. Make sure that the most is got out of the exhaust steam from pumps and auxiliaries. See that the overflow valve on feed-water heaters is not leaking and wasting hot water.

16. Keep the boilers in fit condition by thorough cleaning and repairing. A boiler should never be put back on a load after having been taken down for cleaning or repairs until it has been thoroughly inspected and all defects have been remedied. Irregularities noticed in any boiler during the time it is on the load should be noted in the log in order to be sure that they are taken care of when the boiler comes down for cleaning or repairs.

17. A plant should at all times be clean. A dirty and ill-kept plant is virtually always an inefficient one. A clean plant not only indicates that the plant is being cared for but that the man in charge is trying to run the plant efficiently.

Spillways for Reservoirs and Canals. A valuable summary of existing data on spillways for reservoirs and canals is embodied in Bulletin No. 831, issued recently by the U. S. Department of Agriculture. A review and discussion of the various types with numerous illustrations and diagrams also are included. Special emphasis is given to the design of siphon spillways which includes a summary of this type of structure as built in this country and abroad. A. T. Mitchelson, Senior Irrigation Engineer, is the author.

Relation Between Office Methods, Regulations, and the Water Consumer

Water consumers, as a class, are [illegible] and willing enough to comply with [illegible] department, but there is always in [illegible] a certain small percentage who keep the [illegible] on the jump, and because of whom it [illegible] to bind all consumers to a contract and [illegible] are as near tight as it is possible [illegible] presented Sept. 9 at the [illegible]th annual [illegible] England Waterworks Association, Mr. [illegible] Commissioner of Water Supply, Lynn, [illegible] an interesting resume of the practice in [illegible] city. An abstract of the paper follows:

Contract Stipulations for New Consumers.—[illegible] consumer, when he applies for water in Lynn, is presented with a card form of contract which he [illegible]. This contract contains these stipulations:

> In consideration of the supplying [illegible] hereby agrees to pay for the same [illegible] as are from time to time established [illegible] shall remain in force and be binding [illegible] of Lynn shall continue to supply water [illegible] unless he shall have notified the said [illegible] longer desires the water service and [illegible] notice the name of the new consumer. H[illegible] by the rules and regulations of the Water [illegible] subsequent changes therein and to pay [illegible] piping or special construction as prescribed [illegible] regulations. It is understood and agreed that [illegible] does not guarantee to furnish constant pressure [illegible] service.

If a new owner of property fails to make application for water he receives in due course of time a notice of the following tenure:

> It has been reported to this department that [illegible] owner of the property at blank street. If [illegible] this is to notify you that under the regulations of [illegible] you, as the new owner of this property, have no right [illegible] of water service unless you have made a written [illegible] for water on the prescribed form in this office. You are requested to call at the water office, city hall, within [illegible] and make such application.

Failure to comply with this request is followed up promptly by shutting off the water.

It is necessary to have a contract with the current owner of all property, and to prevent the use of an excessive number of contract cards, each one is provided on the back with space for six transfers of property. The new owner signs this statement:

> In consideration of the continuation of service, I hereby agree to be bound by the provisions of the contract on the reverse side of this card, from blank date as though I were, in fact, the original applicant.

Regulations for Unusual Conditions.—All applicants for water do not submit just the simple request for a single service, but occasionally an unusual and out of the ordinary use for water is contemplated, or a building is so long that the consumer desires the city to go to the expense of putting in two services instead of his putting long feeder lines in the basement. Such conditions are covered in the regulations by the following:

> Owners of property desiring any unusual [illegible] tions or attachments connected with the water [illegible] mit plans and specifications for the [illegible] for his inspection and approval or disapproval [illegible] tion as to whether the same are permissible [illegible] conditions under which their use will [illegible]
>
> Any consumer requiring, because of [illegible] nection with his use of water, a service [illegible] and the street line which is larger than [illegible] to furnish the total amount of water which [illegible] the cost in excess of such a service [illegible] nished, both upon the original installation [illegible] thereof.
>
> Except by special consent of the [illegible] connection will be made for the same premises [illegible] by or emergency services are installed the [illegible] and the entire expense of installation [illegible] service pipe and meter shall be at the [illegible]

The consumer who owns a camp to be [illegible] only a part of the year, or the lunch cart owner who [illegible] in six months [illegible]

[illegible]

Two other types of consumers [illegible] one who wants a service [illegible] and the one who wants something better than the standard service [illegible] get out of it cheaply [illegible] regulations.

[illegible]

Many people apply for water when they are beyond the [illegible] of the main or are on a new street. Two methods are provided for such cases, one for the consumer who wants [illegible] service, and the other for the one who wants to get off [illegible]

> [illegible] per cent of the cost of [illegible] from the time the water is turned into the [illegible]
>
> [illegible] the department will lay at its expense [illegible] ft. of service pipe from [illegible] but not beyond the street line at the front of the [illegible]. The remainder of any [illegible] shall be laid at the expense [illegible]

Conditions Regarding Service Pipe.—The contract which the consumer executes covers not only the supplying of water, but a service pipe and a meter installation. The charge for a service pipe is in accordance with the following:

> All service pipes and street boxes will be supplied and put in by the water department and will be laid from the street main through the cellar wall or front of [illegible]. Service pipes will be laid to the street line without charge, except where ledge work or blasting work, or digging frozen ground is necessary, in which case the applicant must prepare the trench to the ordinary depth required to insure protection against freezing, or if equipment and labor are available such work may, at the discretion of the commissioner of water supply, be done by the water department at the expense of the consumer.
>
> All pipes laid beyond the street line must be charged to the consumer, whether on a new installation or replacement, and water will be shut off for non-payment of pipe bills under the same procedure as for non-payment of water bills.

The consumer who may have two or more houses on a service or sprinklers on his lawn and who would prefer to save the difference between the cost of work done by the city and by plumbers is taken care of by this provision:

> The department shall furnish no meters for [illegible] private [illegible] except [illegible] connected with the [illegible] and then only at the expense of the consumer.

The man who feels that he is better able to judge whether a service pipe should be repaired or renewed than the Water Department is confronted with the following:

> All service pipes between the street line and the cellar wall [illegible] be repaired or renewed by the department when it deems it [illegible] for the protection of the supply or the [illegible] service and the cost of the same charged to the consumer.

Control of Meters by Water Department.—It was recognized by the writer that it is very essential for the department to have complete control of the meters, but with 5,500 services unmetered, and the hope that they will be metered in the near future it was desirable to evolve some means of keeping this control without having to furnish the capital for the installation of so many meters. The following paragraphs from the regulations show how the proposition is handled:

> All users of water through metered services shall pay the cost of a proper sized meter installation and thereafter the maintenance of the same shall be by the water department which shall include all ordinary repairs and replacements. All repairs of injuries to meters from freezing, hot water, or external causes, shall be charged to the consumer. Charges for a new meter installation will, at the discretion of the commissioner of water supply, if requested by the consumer, be levied in equal parts, due and payable with each of the first four quarterly water bills, and all such charges when paid shall be retained by the water department and credited to such meter installation, and in the event of failure to make payment of such charges when due, the water department shall have the right to shut off the water under the same procedure as for other water department charges.
>
> The proper size of meter required for any given service shall be determined by the water department, which shall in all cases furnish the meter to be used, the same to be such type and make as said water department shall deem proper.
>
> All meters shall be set by an employe of the water department, and shall not be moved or disturbed except by the same.
>
> The department shall have the right to remove, repair, or replace any meter at any time it sees fit. All meter installations on services which cannot be shut off for meter repairs shall be equipped with a by-pass at the expense of the consumer.
>
> If, in the opinion of the commissioner, a meter does not fit the conditions of the service installation, the department shall have the right to change such meter and charge or refund the difference in value of the meters exchanged.

Under this method of maintenance of meters by the city, we meet with consumers who, due to the rate at which they use water, desire a very large meter, and others who have stumbled onto the brilliant idea of charging their tenants directly for water. We are prepared for them with the following:

> Any consumer requiring, because of special conditions in connection with his use of water, a meter which is larger than one ordinarily needed to register the total amount of water which he uses, or which is of special material or type of construction, shall be charged the cost of the same and the upkeep of such meter shall be at his expense.
>
> Where the supply of water through a service is covered by a single meter the department will read and maintain but this one meter. If additional or auxiliary meters are wanted for showing subdivisions of such supply, they may be furnished and installed by the department, at the expense of the consumer, who must assume all responsibility of reading and maintaining the same.

Opening and Handling Water Accounts.—After the consumer has had explained to him the particular regulations which fit his individual case and has signed the contract form, the usual orders are sent from the office for the service pipe and meter installations, and an account is opened on a card form which is filed alphabetically in the proper district.

No new accounts are opened except for metered water. The 5,500 fixture accounts are hold-overs, and are gradually being done away with. The houses on fixture rates are inspected and billed twice yearly. The metered consumers receive bills quarterly, but as a matter of service all meters are read monthly, and any excessive flow of water is called to the consumer's attention, that he may put a stop to it at the end of the first month. It is illustrative of the peculiar quirks of human nature, that sometimes consumers ask for a reduction on a water bill because we failed, on our monthly round of readings, to get into their locked up premises and the leak went on for two or three months. Such people are taken care of by this paragraph:

> The department will endeavor to notify consumers of excessive use of water by the monthly reading of meters, but failure to send such notification or inability to read the meter from any cause shall form no basis for allowance on a large quarterly water bill.

It is interesting to note that it costs as much in a year to make 11,000 inspections in houses on fixture rates as it does to make 90,000 meter readings.

One meter bill and one fixture bill only is presented to a consumer owning several pieces of property in one district, the detail being shown on the back of the water bill. All bills are made up in the water office and are sent together with the committment sheets to the collector, from whose office they are mailed to the consumers. At the end of 15 days, 5 per cent is added to all unpaid bills and at the expiration of 30 days the water is shut off. Forty-eight hours prior to the shutting off, a notice is mailed from the collector's office as a final warning.

That most troublesome class of consumers, those who are always looking for a chance to collect something from the city, are pretty well fortified against in the regulations by paragraphs which set forth that the city does not guarantee constant pressure nor uninterrupted service, and that it will not be responsible for any damages resulting from interruption of service, collapsing of hot water tanks, shutting off without notice, dirty water, nor for conditions in consumers' pipes which cause trouble coincident with or following work done by the city on its pipes.

Were the public educated to understand that their waterworks system is an institution which strives to give as much service as possible for the money which the public expends, there would be less and less need for rules and regulations, and it is to that end that we must all work. It is a hard proposition, however, especially in communities made up as Lynn is, of a large proportion of foreign-born people. A great many of these people seem very apt in learning how to beat the water department out of money, but very slow in getting a viewpoint which will cause them not to want to do such a thing, to realize that it is their own business that they are trying to cheat.

Much has been said about education of the public, and no one is a stronger believer in that than the writer, but certainly up to date, as a substitute for penalties and charges, it fails in a city like Lynn. Before using a 5 per cent penalty on unpaid bills, there existed a chronic group of delinquents to whom the 20 ct. summons was a joke, and offers to test meters free to show our faith in their accuracy were met by a deluge of requests from consumers who in some cases had received bills less than a dollar above the average.

While many of the methods described above are stringent, it must not be forgotten that to the good fortune of waterworks officials the vast majority of water consumers scarcely need to know that there is such a thing as rules and regulations.

Co-Ordination of Activities of State Health Engineers

At a conference this spring of state and territorial health officers with the U. S. Public Health Service at Washington, D. C., sanitary engineers from 23 states were in attendance, or from more than half of the 42 states represented. Besides attending the general conference, the sanitary engineers met in a separate section, together with representatives of the Public Health Service. After reviewing briefly the proceedings at the section meeting, Public Health Report (U. S. Public Health Service, Washington, D. C.), for June 4, 1920, says:

The topic, however, of greatest interest and concern to every one of the group of state engineers was the means for co-ordinating the engineering activities of the various states. The need for standardization of policies and exchange of experience among the sanitary engineers in official administrative positions was considered of paramount importance for increasing the efficiency of work in this field. It was the opinion of the state engineers that very much toward the co-ordination and standardization of the activities of state sanitary engineering divisions could be effected and properly accomplished by the U. S. Public Health Service. The specific request was made to the chief of the division of domestic quarantine for the full-time detail of an engineer to collect, analyze, and report to all state engineering divisions, data on the prevailing and proposed activities in this field. For this same purpose permanent standing committees were appointed as follows:

Water Supply (including laboratory procedure), W. H. Dittoe, Chairman.

Sewage and Stream Pollution, V. M. Ehlers, Chairman.

Laws, Organization, Policy and Procedure of State Sanitary Engineering Divisions, H. A. Whittaker, Chairman.

Milk Problems, Theodore Horton, Chairman.

Mosquito Control, R. Messer, Chairman.

Swimming Pool Sanitation, S. De. M. Gage, Chairman.

Cities Change from Commission Plan to City Manager.—According to such information as is available some 17 cities formerly operating under the straight commission form of government have changed to the city manager plan. Among these cities are Amerillo, Tex.; Colorado Springs, Durango, and Montrose, Colo.; Wichita, Kans.; Rome, Ga.; McAlester, and Muskogee, Okla.; Tallahassee, Fla.; Sturgis, Mich., and Morehead City, N. C. The changes by ordinance are: Altoona, Pa.; Eaton Rapids, Mich.; Weatherford, Okla.; Watervleit, N. Y., and Anoka and Morris, Minn.

Use of Motor Vehicles by Water Department

Some 35 automobiles and [illegible] water distribution department [illegible] Mass. Experiences with these [illegible] Mr. George H. Finneran, Superintendent [illegible] in a paper presented Sept. 19 at [illegible] of the New England Waterworks [illegible] the notes following are taken.

The motor vehicles are mostly [illegible] ger transportation and Ford 1 ton [illegible]. The department is not entirely motorized [illegible] visions to be made for heavy hauling [illegible] for by horses, and there are [illegible] paving, for instance, where a [illegible] nomical. It has been found that [illegible] automobile were obtained by keeping [illegible] possible. To reduce stopovers [illegible] to prepare the route ahead of time [illegible] the driver calls up headquarters [illegible] job and receives directions for the [illegible] often may be conveniently near the [illegible] and thus save doubling back to the spot after [illegible] quarters.

In the "off and on" work, which [illegible] ting off services to permit private [illegible] and afterward turning on, this method of [illegible] headquarters is almost indispensable. [illegible] the emergency service and is found of [illegible] otherwise.

The great trouble with automobiles as with [illegible] of the work, is the personal factor. It is found that many men who drive cars do not understand the principle of the gasoline engine. They do not know the [illegible] of this or that part. They are not sensitive to the little warnings which the machine gives out preceding its eventual breakdown. They are not sympathetic towards its eccentricities. They simply start the car, steer clear of obstacles, go as fast as they can, and stop in as short a length as possible. Thus will they continue until something occurs to prevent the car from working properly and then there is a job for the repairers. They take the car you give them in place of the disabled one and repeat the operation. We try of course to show them the trouble and explain the cause but somehow history repeats itself.

We find it necessary to pay strict attention to the oiling and proper inflation of the tires. Partial deflation of tires shortens their life considerably. We have a night man whose duty it is to inspect each car in the garage. If he finds any serious trouble or defect he places a tag on the car forbidding its use the next day and reports the trouble in the morning to the auto repairers. He puts oil into the crank case, attends to any flat, down or partially flat tires, fills the gasoline tank, turns the grease cups [illegible] and polishes some of the cars, puts water in the radiators, etc. In the morning one of the repairers arrives before [illegible] o'clock and starts up some of the obstinate cars of which there are always a few. The idea is to have the car ready for immediate use when the day's work begins.

Many of the cars are driven by the men [illegible]. For instance, the district foremen drive [illegible] the plumbers and meter repairers likewise [illegible] "off and on" men, the engineers, and even the division engineer, the head of the department. We try as far as possible to eliminate dead weight on the cars in the form of chauffeurs who only drive.

We keep the usual records of oil, gasoline, tires, [illegible] etc., but while such records are valuable [illegible] they do not tell the whole story when used for comparison with the mile as a unit. There are miles and there are miles. Some of our cars are used exclusively in the congested parts of the city. Some in the suburbs. A mile in one section means much more than a mile in the [illegible]. Stopping and starting necessary in the downtown streets, the bad pavements in some sections, the hills in other sections, all tend to influence differently the wear and the tear on the tires and machinery and the consumption of gasoline and oil. There are such things as hard miles and easy miles. If you will notice, the tire manufacturers are not adjusting on the basis of numerical miles. They wish to know if the tire [illegible]

[illegible]

Illinois Waterway Contract Provisions for Taking Care of Increases in Labor and Material Prices

[illegible] Illinois Waterway [illegible] Water [illegible] of the Illinois Department of Public Works and Buildings [illegible] the state will absorb 80 per cent of any increase [illegible] of labor or cost of materials. These provisions of the contract are as follows:

[illegible]

Occupation	Hourly rate	Occupation	Hourly rate
[illegible]	$0.70 to $0.[illegible]	[illegible]	$[illegible] to $[illegible]
[illegible]	.60 to .65	[illegible]	.60 to .65
[illegible]	[illegible]	[illegible]	[illegible] to .60
[illegible]	.60 to .65	Pipe fitter	.70 to .75
[illegible]	[illegible]	Pipe fitter helper	.60 to .65
[illegible]	[illegible] to 1.[illegible]	Pump man	.60 to .65
Carpenter, [illegible]	.70 to .75	Rigger	.60 to .65
Carpenter, helper	.60 to .65	[illegible]	[illegible] to .80
[illegible]	.70 to .75	Teamster	.55 to .60
[illegible]	.60 to .65	Team and driver	1.00 to 1.10
[illegible]	.60 to .65	Truck driver—heavy	$[illegible] to $[illegible] week
[illegible]	.80 to .90		
[illegible]	.60 to .65	Truck driver—light	$25 to $27.50 week
Fireman	.55 to .60		
Labor [illegible]	.55 to .60	Watchman—$100 to $110 month.	
Labor	.50 to .55		

[illegible] work for eight hours' pay. Overtime in excess of eight hours shall be rated [illegible] Sundays and legal holidays shall be [illegible] double time [illegible] wages. It is further mutually agreed [illegible] any one or more of the wage rates above the upper limit given, and that [illegible] department [illegible] approval and [illegible] the state. The state will [illegible] for labor [illegible] on the monthly estimates [illegible] contractor. The contractor [illegible] with the approval [illegible] the state and the [illegible] deduct [illegible] contractor.

[illegible] between [illegible] prices for [illegible] named [illegible] following schedule of prices [illegible]

[illegible]

[illegible] per net ton f. o. b. cars [illegible] Western [illegible] Association [illegible]

[illegible] In the event that it becomes [illegible] of the department, to purchase [illegible] than scheduled, the state shall absorb [illegible] per cent and the contractor twenty [illegible] per cent [illegible] for material furnished, and in the event that any [illegible] lower than [illegible] the state and the contractor shall share equally the saving for materials [illegible]

XXXVIII. Freight Rate Guarantee. Any increase in freight [illegible] subsequent to the [illegible] of this contract and which [illegible] price of materials scheduled will be entirely absorbed by the state.

Instructions for Operators of Mechanical Pressure Filters*

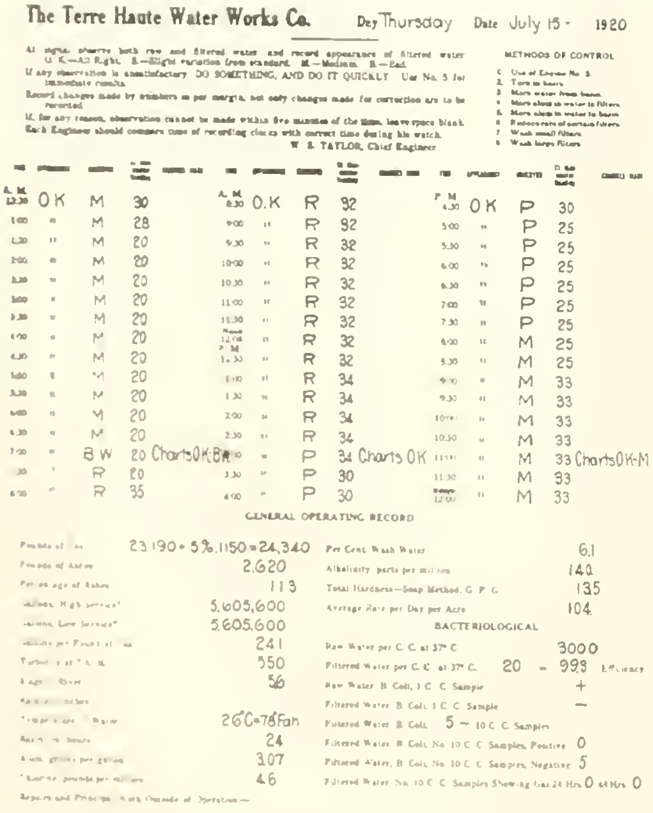
By DOW R. GWINN
President and Manager Terre Haute Water Co.

Human nature is very much the same in Indiana and Illinois as it is in New York and Oregon. The tendency is to move along the line of least resistance—to do things in the easiest way. There are cases where the easiest ways and efficiently are not synonymous terms. In operating water plants, the author has tried to find the best way of doing things, and then to adopt them as standard methods, even if they are difficult, and holding to them until better ways have been found. After methods have been adopted, it is discouraging to find later on that they are not being observed by assistants. On inquiring why certain methods have been discontinued, the usual answer would be, "We don't do it that way any more." And further inquiry would not disclose why or when the method was discontinued.

The idea of printing instructions was then tried, it has worked very well. There is an advantage in having a particular time to do certain things such as cleaning the heater, blowing down the boilers, taking indicator cards, making evaporation tests, etc.

The instructions are typewritten and are kept in a loose leaf binder. Changes can be easily made and additional sheets may be readily added. No method is so sacred but what it can be changed by the manager. The employes are encouraged to suggest better methods and when tried and found to be advantageous, they are substituted for old ones. Each employe is supposed to read the instructions once a month; he may select his own time while on duty for the reading. A sheet of properly ruled paper is enclosed in the file on which are the list of employes and each employe records the date when he reads the instructions.

The Terre Haute Water Co. takes its supply from the Wabash River and is a direct pumping plant, there being no standpipe or elevated reservoirs which could be used if pumps were not in operation. For pumping into the distribution system, there is a 10,000,000 gal. vertical triple expansion and a 6,000,000 gal. vertical compound; also smaller pumps. For delivering to the sedimentation basin, there is a centrifugal pump operated by a compound high speed engine connected with a rope drive. Steam is generated in water tube and fire tube boilers with hand firing. A vaccum pump for exhausting air from the suctions of the principal pumps is a part of the equipment. There are 22 mechanical pressure filters. There is a sedimentation basin with sufficient capacity for approximately 2 to 5 hours' subsidence. This is only used when the turbidity exceeds,' say, 60 on the Jackson Turbidimeter, or about 55 per cent of the time. The turbidity of the river water ranges from 25 to 3,000. There are 8,210 consumers; 97.7 per cent of all service pipes are metered, including private fire lines for automatic sprinklers.



The Terre Haute Water Works Co. Day Thursday Date July 15 - 1920

At signals observe both raw and filtered water and record appearance of filtered water. O. K.—All Right. S.—Slight variation from standard. M.—Medium. B.—Bad.

If any observation is unsatisfactory DO SOMETHING, AND DO IT QUICKLY. Use No. 5 for immediate results.

Record changes made by numbers in [illegible] margin, but only changes made for correction are to be recorded.

If, for any reason, observation cannot be made within five minutes of the time, leave space blank.

Each Engineer should compare time of recording clocks with correct time during his watch.

W. S. TAYLOR, Chief Engineer

METHODS OF CONTROL

1. Use of Engine No. 3.
2. Turn in basin.
3. More water from basin.
4. More alum in water to filters.
5. More alum in water to basin.
6. Reduce rate of certain filters.
7. Wash small filters.
8. Wash large filters.

A. M. 12.30	OK	M	30		A. M. 8.30	O.K	R	32		P. M. 4.30	OK	P	30	
1.00	"	M	28		9.00	"	R	32		5.00	"	P	25	
1.30	"	M	20		9.30	"	R	32		5.30	"	P	25	
2.00	"	M	20		10.00	"	R	32		6.00	"	P	25	
2.30	"	M	20		10.30	"	R	32		6.30	"	P	25	
3.00	"	M	20		11.00	"	R	32		7.00	"	P	25	
3.30	"	M	20		11.30	"	R	32		7.30	"	P	25	
4.00	"	M	20		Noon 12.00	"	R	32		8.00	"	M	25	
4.30	"	M	20		P. M. 12.30	"	R	32		8.30	"	M	25	
5.00	"	M	20		1.00	"	R	34		9.00	"	M	33	
5.30	"	M	20		1.30	"	R	34		9.30	"	M	33	
6.00	"	M	20		2.00	"	R	34		10.00	"	M	33	
6.30	"	M	20		2.30	"	R	34		10.30	"	M	33	
7.00	"	BW	20	Charts OK-BW	3.00	"	P	34	Charts OK	11.00	"	M	33	Charts OK-M
7.30	"	R	20		3.30	"	P	30		11.30	"	M	33	
8.00	"	R	35		4.00	"	P	30		Midnight 12.00	"	M	33	

GENERAL OPERATING RECORD

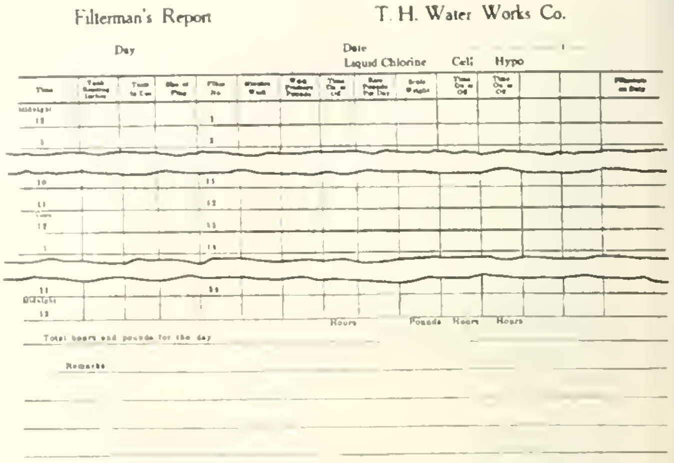
Pounds of [illegible]	23190 + 5%.1150 = 24,340	Per Cent Wash Water	6.1
Pounds of [illegible]	2.620	Alkalinity parts per million	140
[illegible]	113	Total Hardness—Soap Method, G. P. G.	135
Gallons, High Service*	5,605,600	Average Rate per Day per Acre	104
Gallons, Low Service*	5,605,600	BACTERIOLOGICAL	
Gallons per Pound of [illegible]	241	Raw Water per C. C. at 37° C	3000
Turbidity at 7 A. M.	550	Filtered Water per C. C. at 37° C.	20 — 99.3 Efficiency
Stage of River	56	Raw Water B. Coli, 1 C. C. Sample	+
Rainfall, inches		Filtered Water B. Coli, 1 C. C. Sample	—
Temperature of Water	26°C=78°Fah	Filtered Water B. Coli, 5 — 10 C. C. Samples	
Basin in hours	24	Filtered Water B. Coli, No. 10 C. C. Samples, Positive	0
Alum, grains per gallon	3.07	Filtered Water, B. Coli, No. 10 C. C. Samples, Negative	5
Chlorine, pounds per million	4.6	Filtered Water No. 10 C. C. Samples Showing Gas 24 Hrs. 0 48 Hrs.	0

Repairs and Principal Work Outside of Operation—

*No allowance for slippage.

Daily Half Hour Report Sheet.

At the plant, a program clock is provided which summons the attendants every half hour to examine the water; this is just a visual examination of the raw and filtered water and a record of the appearance of the water is made. This is necessary because of sudden changes in the turbidity of the raw river water.



Filterman's Report T. H. Water Works Co.

Day

Date

Liquid Chlorine Cell Hypo

Total hours and pounds for the day

Remarks

Time
Filter No.
Filterman on Duty
Midnight
12
1
10
11
Noon
12
1
11
Midnight
12
1
2
11
12
13
14
22
Hours
Pounds
Hours
Hours

Form for Filterman's Report. Actual Size of Blank, 11x8½ In.

The following instructions for filtermen have been found to be satisfactory for the Terre Haute plant:

Filtermen will attend to their usual duties as they have been instructed and such special work as they may be given.

Filtermen, immediately upon coming on watch, shall inspect the condition of the alum tanks and note whether or not the proper feed is being maintained. Following this, they shall also inspect the basin when it is in use and see if the water is being properly treated and coagulated. If chlorine cell is in use, then inspect condition at the cell as soon as practicable after the other matters above have been attended to.

Filterman on watch will, soon after coming on, inspect recording water pressure gages for operation and time setting and record same on daily half hourly report sheet. Filtermen will sign name to water pressure charts in space that he is on duty, also on his daily report sheet.

The filtermen will usually be informed by the chief engineer by a suitable mark on the chemical feed chart, of the desired rate of alum feed and when the basin is not in use, the rate shall be made to correspond with the changes in speed of the Allis engine, by changing the alum feed plugs as my be necessary, noting the plug changes on daily report sheet. When the basin is in use, the rate of alum food may be given, or it may be left to the judgment of the filtermen; usually, in a changing river, it is not practicable to fix the alum rate, but it must be changed as necessary to get a suitable coagulation. In the absence of definite instructions or a changing river, try to use enough to get good water and on the other hand, not to waste any alum. The practice of taking a glass of water as the water enters basin and setting it down while observing the basin, then looking at the glass again, is a valuable help in determining suitable coagulation.

If the river is changing when basin is off, the conditions should be watched closely and basin put on at about 50 to 60 turbidity.

Filtermen will keep filter plant and basin neat and clean; upon a fire alarm or call bell signal, they will report to the engineer promptly and assist in [illegible] may direct.

---

*Abstract of a paper presented Sept. 9 at the 39th annual convention of the New England Waterworks Association.

Any stoppage of alum or chlorine [illegible] be in use, shall be noted on the [illegible] the time and duration of such stoppage [illegible] reading the gage on the alum tank [illegible] record readings hourly.

In starting to wash filters, the wash [illegible] very slowly, taking about five minutes [illegible] rate of wash.

The length of time to be used in washing the filters will be given from time to time by the chief engineer and shall remain the same until changed by [illegible]. Ordinarily small filters should be washed about [illegible] minutes and large filters about 15 minutes.

Every time each filter is washed, the effluent should be turned into the sewer for about three minutes before turning into distribution system. Every time after washing filter (and before turning on) examine effluent within a few minutes after turning in by filling pint Mason jars. These jars are to be kept for observation by the chief engineer.

If during the filter washing any unusual behavior of any filter is noticed, indicating that something is wrong with it, the filter should be cut out of service and reported to the day man for examination.

The turbidity in the raw water is taken daily by the chemist in the laboratory at about 9 a. m. Where the condition of the water is not changing rapidly and the turbidity does not exceed 100, the observation made at that time can be used as a guide for feeding chemicals, and additional tests by the filtermen will not be necessary. When, however, the turbidity is in excess of 100, and especially if it is subject to rapid changes, each filterman is to make at least one determination for turbidty during his watch and the results are to be recorded upon the Filtermen's Daily Report Sheets. During such periods, samples are to be collected at the following places:

(1) The raw water at the sink, if this is found to be representative.

(2) The north end of the settling basin just east of the center partition wall and before passing to the west side of the settling basin, and

(3) The settled water at the sink after it has passed through the settling basin and before going to the filters.

The Jackson turbidimeter (candle) is to be used in taking turbidities where these exceed 25 p.p.m. If the turbidity falls below this amount, silica standards are to be used.

Filter Plant Operation at Harrisburg, Pa.

The cost per million gallons for filtering water at Harrisburg, Pa., for the year 1919 was $9.34, according to the last annual report of the Water Department of that city. The cost is distributed as follows: Coagulant $1.73, supplies $0.83, repairs $0.37, labor $5.20, and laboratory $1.21, all per million gallons. The average daily consumption was 9,099,122 gal. or about 107 gal. per capita per day; 85.7 per cent of the services are metered.

The turbidity in the raw water averaged 63 parts per million, color 12.1 parts per million, and the alkalinity 15.8 parts per million. An average of .588 grains of alum per gallon were used. It was necessary to use soda ash 29 days during the year to increase the alkalinity. The average period of service for the filters was 16 hours and 19 minutes. The total cost of supplying water, figured on total maintenance, was $31.47 per million gallons; including sinking fund and interest it was $50.87 per million gallons.

New Record for Traffic Through Panama Canal.—A new high record for a month's traffic through the Panama Canal was established in August. According to the Panama Canal Record 266 commercial ships made the transit carrying [illegible]740 tons of cargo. Their aggregate net tonnage, on the basis of Panama Canal measurement, was 951,3[illegible] tons. The tolls collected amounted to $936,209.11. The previous record month was December, 1919, when 260 ships, of 92[illegible],726 net tons, carried 924,479 tons of cargo and paid $8[illegible] in tolls. The average number of commercial ships passing through the canal per month during the current calendar year up to August was 221.57; including the August traffic the average per month this year has been 22[illegible].

Protection of Surface Water Supplies Against Contamination*

BY [illegible] GOODNOUGH

Chief Engineer, Massachusetts [illegible]

One of the most serious difficulties with which water works officials and health officers have to contend is the enforcement of necessary sanitary regulations for the protection of the [illegible] of water supply sources. This is especially true of that most [illegible] which follows from the use of such reservoirs for boating and fishing. If present tendencies continue [illegible] can be awakened to the situation, many existing water sources are likely to become contaminated and there is [illegible] that in places where the public is now getting the benefit of the very best uncontaminated drinking water sources [illegible] will have to be had to methods of purification or filtration.

Year after year bills are presented to the legislature to authorize boating and fishing on ponds and reservoirs used as sources of water supply, and as time goes on their advocates become more and more insistent in their appeals for such privileges. The Department of Public Health and the water departments of the various cities, towns and districts are constantly urged to grant these privileges and, as one water commissioner has stated it, speaking of his own city,

> "The political interests [illegible] has [illegible] and the political authorities [illegible]. With a [illegible] would rather [illegible] to gratify the wishes and pleasures of [illegible] is [illegible] jeopardize the health of [illegible]."

To the average man who desires to fish in a water supply reservoir it seems incredible, if not wholly absurd, that danger to anyone's health might result from allowing him to fish for a few hours occasionally in a water supply reservoir. When his request for such a privilege is denied he is naturally unprepared to accept the reasons given for such denial and often seeks to have the rules set aside in his favor. The effort to have the rules set aside has thus far been confined largely to sanitary regulations relating to great ponds as distinguished from other sources of water supply, the reason brought forward being that the great ponds were in the early days of the settlement of Massachusetts set apart for the use of the public. Of course it has been decided by the courts time and again that the legislature could grant the use of such ponds for specific purposes like water supply and authorize the enforcement of sanitary regulations under the police power of the state for their protection, and the plea as to the public right of fishing in great ponds is adopted merely because of the possible advantage such as argument may have in obscuring the real issue. It cannot be doubted that if rights to fish in great ponds were to be granted pleas would then be made for the rights to fish in artificial reservoirs possibly because these reservoirs had replaced streams in which fishing was formerly carried on.

To further aid this plea various arguments are commonly brought forward by the advocate of the fisherman which will not stand much scrutiny. He believes, or affects to believe, that the reservoir in which he wishes to fish has become so filled with fish that they are a detriment to the quality of the water. Another claim often made to urge the desirability of allowing fishing in reservoirs is that the presence of fish results in the pollution of the water and that the fish should be removed for that reason alone. This claim is hardly worthy of serious attention. Concerning it, however, Professor Rosenau, in a report to the Water Board of the city of Fall River made the following sufficient answer:

> "Fishermen take out a certain number of fish during the short season [illegible] permitted; the few fish thus hooked, however, have little [illegible] in decreasing the total number of fish in the pond, [illegible] law of nature that thinning out the number [illegible] gives the survivors an easier time to find a livelihood [illegible] the multiplication of the species is favored by the [illegible]. In any event the number of fish in the pond will always be limited by the amount of available food and a better way to diminish the number of fish is to prevent organic pollution which directly and indirectly furnishes sustenance for animal life.
>
> [illegible] the fish in themselves do not pollute the water [illegible] appreciable extent. It is not conceivable that the few fish taken out at the [illegible] North Watuppa Pond [illegible] diminish the number of fish or appreciably [illegible]

---

*Abstract of a paper presented Sept. 7 at the 39th annual convention of the New England Waterworks Association.

> [illegible] the pollution of the pond. Even though the pond was overstocked with fish it would not render the water as undesirable as [illegible] from one person with typhoid fever dysentery [illegible] the spittle from a person having tuberculosis. In [illegible] practically all the infections serious to man which [illegible] water come from man and not from fish. Owing [illegible] of fish the general effect of their presence in the [illegible] rather to keep the pond clean than to soil it. . . .
> [illegible] Thirty Ninth Annual Report [illegible] Water Board, Jan. [illegible]

With regard to other animals, no claim has thus far been advanced that they pollute reservoirs, excepting in the case of birds, which did cause the serious pollution of Spot Pond, Massachusetts, several years ago. The source of the trouble was the gulls who in the winter or early spring would fly inland from the mud flats on the coast and settle in the waters and upon the rocks in Spot Pond. Means were quickly found, however, to prevent contamination from this source. It should be added that the pollution chiefly feared was that carried upon the bodies of the gulls themselves, who obtain their food in part at least, in the polluted waters of nearby harbors. Pollution from their excreta also is of course objectionable, but, as Dr. Rosenau says, "practically all the infections serious to man which enter a drinking water come from man."

In recent years a somewhat more plausible claim has been made that fishing should be allowed in order to increase the food supply, regardless of the fact that the value of the food obtainable in this way is insignificant as compared with its cost. However, tenuous or absurd a reason may be presented to a governing body to back up a petition for permission to fish in a water supply reservoir, it is sure to have many advocates and few or no opponents except the officials upon whom rests the responsibility of preventing the pollution of the water supply and protecting the public health, and water works and health officials whose duty it is to protect the interests of the great public are often marks for unfair and unreasonable criticism.

As one water commissioner has stated it, "we all know that boating and fishing lead to pollution." This will be realized more fully if we remember always that there are persons who are naturally insanitary in their habits but who are entirely unconscious of it and that there is of course a very large number who have no comprehension of the relation between filth and disease. If boating and fishing on reservoirs are allowed there cannot be the slightest doubt but that pollution will occur, and there is no way of controlling it or stopping it except by preventing this practice.

A study of typhoid epidemic shows:

1. That a very slight pollution of typhoid fever germs may infect reservoirs of very large capacity sufficiently to cause great epidemics of tphoid fever.

2. That the typhoid germ can survive the severe winter weather of a northern climate and retain its virulence.

3. That the germ can be carried long distances in water and may survive through many weeks of time.

In some of the epidemics the exact cause was never discovered, and this fact brings up another discovery of modern sanitary science relating to this disease, namely, that there are typhoid carriers, so-called, who, though apparently in good health are capable of spreading tho disease. Furthermore, there are so-called walking cases of typhoid fever; that is, cases so mild that the patient is never obliged to go to bed, and there are others who are infected for a period of several weeks before finally coming down with the disease. Where numbers of persons are allowed to resort to ponds and reservoirs for boating and fishing there will inevitably be carriers or possibly walking cases among them, and the infection of the water supply is not only possible but probable. Water boards and superintendents cannot subject a man who comes for a permit to fish to an examination to determine whether or not he is in good health, and any man could get a permit even though he is a typhoid carrier, if he is not ill and is unaware that he carries the germs of the disease.

The experience in Massachusetts of the effect of allowing boating and fishing on water supplies is limited because very few water supplies have been so used to any extent for many years. In the few cases in which ponds have been thrown open to the public by the removal of restrictions or by the granting of licenses, however limited, there have been enough cases of extreme and disgusting pollution to furnish experience of what would occur if this practice should be made general. The only notable outbreak of disease traced to fishing in a pond or reservoir as the probable cause was an epidemic of gastroenteritis in Peabody in 1915. In this epidemic about 500 cases of illness occurred but no deaths, and the epidemic was perhaps exceptional in the fact that it was not followed by typhoid fever as is usually the case.

In another town there occurred a few years ago a sudden outbreak of a dozen or more cases of typhoid fever occurring in all parts of the town, and all of them appearing within 10 days to two weeks after the Thanksgiving holiday. The water supply in this case was taken from a running stream half a mile below a pond formed by a group of springs at a time when the flow of water was in excess of the quantity of water used by the town. The watershed was uninhabited, but a number of empty cartridge shells about the shore of the pond and along the stream above tho intake indicated that the place had recently been visited by hunters, from whom it was presumed the infection was derived.

It has been urged that the danger of injurious contamination is less where the contaminated water of one pond has to pass through another and uncontaminated reservoir before reaching the waterworks intake, and this may not be wholly untrue in some circumstances, but the contamination of the great reservoir at Scranton and the reservoir at New Haven indicates that such a condition may not be adequate protection since, if one pond becomes thoroughly infected, the other would naturally also become infected if the polluted water flows into it. There are cases where the danger of contamination of a pond used directly for water supply purposes by the pollution of another pond which is its tributary may be remote, but the experiences already described indicate that this condition cannot be relied upon to protect the health of those to whom the water is supplied.

A most instructive example of what may happen when a water supply reservoir is thrown open for public use has been furnished recently in the city of Haverhill. Pending the completion of certain sewer connections within the watershed of Lake Saltonstall, it was deemed advisable by the State Department of Health that the use of this lake should be discontinued temporarily at least until assurance could be had that the water was safe for drinking. The water board had been importuned to grant permits for boating, fishing, skating, etc., on this lake, and at the time when its use had been temporarily discontinued the water board was requested and practically directed by the city government to throw open the lake to public use until it should again be needed as a water supply. The lake is located close to the best residential quarter of the city and it is interesting to note that more than one of the owners of land in the neighborhood of the lake favored the granting of the petition. In accordance with the request of the authorities, the rules of the State Department of Health for the sanitary protection of the lake were suspended and it was thrown open for public use. The results were just what was expected by those familiar with waterworks matters but wholly unexpected by many if not most of the petitioners who desired the opening of the lake. The lake and its neighborhood became the resort of persons who made the place unsafe and did much damage to the estates in the neighborhood. A few fish were caught from the lake in the beginning, but the supply of fish was apparently quickly exhausted.

This incident shows clearly the result of the unregulated use of a water supply reservoir for boating and fishing by the public. It will be urged of course that such conditions would not follow if boating and fishing were limited, but experience has repeatedly shown that attempts to limit boating and fishing on a water supply reservoir are generally utterly impracticable. Attempts to limit the number of permits or to discriminate between applicants are sure to lead to charges of favoritism and are impracticable. This is well illustrated by a little incident connected with the effort that has been continuously made for many years by certain inhabitants of Natick to secure the privilege of fishing and boating in Lake Cochituate. During the war it was urged that fishing should be allowed from boats in order to add to the food supply, and the Metropolitan Water Board finally agreed to grant 10 permits for fishing in Lake Cochituate within limits designated by them, the permits to be given to persons selected by the Board of Selectmen of Natick. No selections were ever made, the reasons being, as stated by a representative of the town before the Legislature that no board of [illegible] who should attempt to des[illegible] zens to be granted such a p[illegible]

To us in this day the [illegible] demics of the past united to t[illegible] ones seem self-evident but [illegible] regarded by the boatmen and [illegible] to water supply reservoirs [illegible] and city councillors upon wh[illegible] through the fatuity of legislat[illegible] the policy of the strictest sa[illegible] ply reservoirs is broken dow[illegible] easily follow Furthermore [illegible] ing consequences may result [illegible] responsible for such a calamity [illegible] great epidemics of earlier years [illegible] its application to water sup[illegible] is the case at the present da[illegible] in any community and especially [illegible] thorough knowledge of the [illegible] their drinking water is derived [illegible] with the requirements of wat[illegible] great majority if they think of [illegible] the city or town government or [illegible] officials to see to it that the water [illegible] tained and adequately protected and [illegible] ures necessary for such protection Nevertheless should an epidemic occur as a result of the [illegible] or thoughtlessness of those who seek to use water supply reservoirs for their own pleasure, the blame [illegible] not upon the fishermen but upon the legislators or officials who yielded to their importunities.

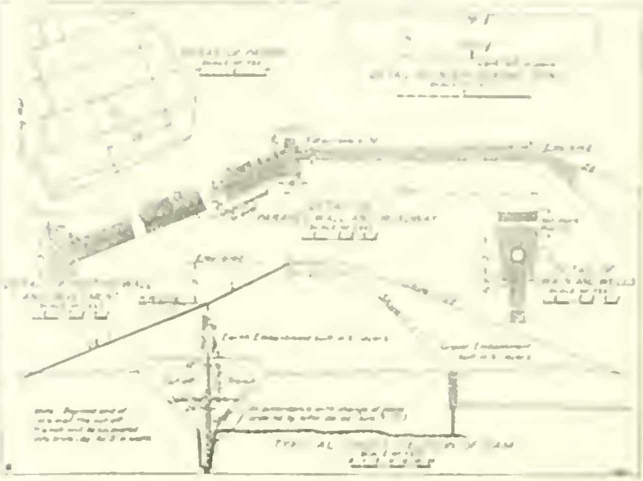
Already large sums have been collected in damages in cases where injury has resulted from the drinking of polluted waters and where negligence on the part of the municipality or water company or the agents in charge of its water supply has been proved It is not impossible that in the future individuals may be punished for such neglect as has happened to those whose negligence has resulted in accidents on railroads and in the operation of other public utilities. So long as the active and enterprisig seekers for the use of water supply reservoirs continue their efforts to secure the special privileges which they seek, those charged with the guardianship of water supplies must be prepared at all times to meet their arguments They must point out clearly to legislative bodies the great danger to the many involved in yielding to the selfishness of the few, whether through ignorance or, worse still, through fear of political consequences Finally, constant vigilance must be maintained by health and water supply officials and others interested in the protection of the public health if this growing menace to the purity of water supplies is to be removed Any attempt to impair the protection of even a single source of supply must be treated as a threat to all and be met by united opposition.

New Definition Wanted of I. C. C. Term "Engineer of Mechanics."—The American Association of Engineers presented to the Interstate Commerce Commision on Oct. 1 a request for a new definition of the term "Engineers of Mechanics" at a hearing granted by the Commission in response to the association's request. The term "engineers of mechanics," defined after the I. C. C. hearing on March 1[illegible], now includes civil engineers classified as subordinate officials. The petition of A. A. E. is for a new definition which will include all professional engineers in railroad service who are classified as subordinate officials. The definition recommended follows:

"The American Association of Engineers recommends that there shall be included in the group within the term 'Subordinate officials" the following: Technical engineers This class shall include all professional engineers, [illegible] engineers, engineer assistants, instrumentmen, rodmen, chainmen, designers, draftsmen, computers, tracers, chemists, architects, engineer supervisors, engineer inspectors and all other employes engaged in office or field work in any department and performing engineering work. None of the foregoing who have authority to employ, discipline or dismiss subordinates shall be included." The Commission has taken the matter under advisement and will probably make a decision within the next two weeks

Failure of Concrete Slab Facing of Dam and Method of Making Repairs

During a severe windstorm [illegible] April [illegible] Minatare Dam of the North Platte project [illegible] Reclamation [illegible] Mr W. H. [illegible] Assistant [illegible] U. S. R. S. [illegible]



Cross Section and Details of Minatare Dam, North Platte Project.

in new construction The matter following is taken from the article

The reservoir water level at the time accident occurred was approximately 3 ft below that of maximum capacity It is estimated that the waves reached a maximum height between crest and trough of 7 to 7 ft during the storm The wind was from the north northeast, and the face of the dam, which lies due east and west, consequently received almost the full effect of the waves. It is very seldom in this vicinity that so violent a wind comes from this quarter The length of exposed water surface above the dam in this direction was about 1¾ miles.

The slope on the reservoir side of the dam is 2½-1 from the base of the dam to the elevation of maximum high water. Above this point the slope is 2.1 to the top of the earth dam for a vertical height of 15 ft A concrete parapet wall surmounts the top of the concrete slab 1 ft above the top of the dam thus affording a total freeboard above the high water level of 16 ft The effective freeboard at the time of the storm was therefore about 19 ft

The concrete facing was made up of rectangular slabs 10 ft by 20 ft and 8 in. thick, with the 20 ft dimension running up and down the slope of the dam These slabs were not steel reinforced with the exception of a few short bars placed near the horizontal joints of the slabs to strengthen them in transmitting the component of slab weights lying along the slope of dam The effect of this reinforcing is practically negligible as far as the strength of the slabs is concerned The horizontal joints between slabs are rounding, as shown in the accompanying drawing, the transverse or sloping joints are straight vertical joints All joints have one thickness of rubberoid roofing inserted to separate adjacent slabs

The break in the paving was located between station 21+80 and 23+30 of the original dam stationing, comprising a net length of 150 ft The width of the break measured along the dam slope was about 28 ft., extending from a slab joint located 9 ft above the maximum high-water level of the reservoir to a line located roughly about 6 ft below the same datum or 3 ft below the water level at the time of the storm The slabs above the high-water line were not badly broken.

but for the most part were simply dropped down or left standing on a steep slope against the nearly vertical earth face left at the back of the washout along the dam.

There is no doubt that the position in which these slabs were left prevented a more extensive earth washout from the dam before the storm subsided. The lower portions of the slabs seem to have been badly cracked or broken by the violence of the storm and were shoved out over the unbroken pavement below, together with the earth filling washed out, so that the exact condition of the paving still intact beneath is hard to ascertain, as it is submerged under water. A total of about 550 cu. yd. of the earth filling of the dam was removed during the storm, the major portion of which was dropped onto the submerged paving below the break.

During the fall of 1919, when the reservoir was empty, a series of tests was conducted to determine whether any hollow spaces existed beneath the slabs near the high-water line. Holes about 1 in. in diameter were chiseled through the slabs at what appeared as likely spots for investigation, but no hollow spaces of any consequence were found, the largest space found being not over 2 in. deep and not over 3 or 4 in. wide. The results of these tests indicated that there was at that time no serious cause for apprehension in regard to hollow spaces existing beneath the slabs.

The reservoir was again filled during September and October, 1919, to full capacity or maximum high-water level, and dropped gradually due to seepage and evaporation losses to the level existing on April 10, 1920. During this time several severe windstorms occurred, and it is probable that these intervening storms gradually undermined one or more portions of the lining, as explained later, so that it was not in shape to resist the extra severe storm which caused the damage.

Probable Cause of Paving Failure.—The Minatare Reservoir has been in service some five years, and during that time numerous cracks have developed in the concrete facing, and several of the transverse or sloping joints have opened up to some extent. Most of these cracks or openings are negligible as far as any possible water action getting through them is concerned, but others have reached a critical width of about 1¼ in., so that with violent wave action it is possible and indeed probable that some of the underlying material which is mostly coarse sand has been washed out, particularly along those cracks running generally up and down the dam facing. There was evidence of this along one of the sloping slab joints, which was exposed by the break, where a small pocket about 3 in. deep was visible directly under this joint at a point at least 5 ft. above the water level. Such pockets would probably reach a maximum size at or near the water level, and it is conceivable that when such a pocket had reached a certain size the impact effect of heavy masses of water falling on such a slab might ultimately cause settlement of one edge of the slab, especially should there happen to be a longitudinal crack in the slab that would readily allow such settlement to take place. Granting that such a settlement could take place it is readily seen how the cracks might then open up to such a degree as to wash out still more material, until actual undermining would take place, and the slab would drop and expose the underlying material to direct wave action, so that the destruction of a considerable portion of the dam facing would occur in a relatively short time in a heavy storm. It is believed that this is the method by which the recent slab failure proceeded, notwithstanding that there may have been other contributing causes. There is some evidence that there has been a slight outward displacement or bulging of the paving immediately below the break and well below the water surface. This point has as yet not been determined, but if proven might also have an important bearing on the direct cause of failure.

Method of Making Temporary Repairs.—Temporary repairs of the break were started on the morning of April 12 by a force of six laborers breaking up the large pieces of dislodged concrete slabs with gads and sledges. The pieces were left as large as practicable for handling and were then built into a bulkhead or wall along the lower edge of the break which was under 2 to 3 ft. of water. This wall had a minimum thickness of about 3 ft., and was built as tight as possible, using only the rough broken pieces of slab. There was enough broken slab available to carry this wall to a height of about 3 ft. or about 1 ft. above the present water level.

Coarse gravel was in the meantime hauled from a hill west of the dam and dumped on the crest of the dam immediately above the break. A single pulley block was anchored near the water line with a team on one end and a mormon scraper on the other. The team was kept on the dam and two men handled the scraper, pulling the gravel over the parapet wall and down into the cavity, which was thus filled to within 2 ft. of the original surface of the paving. A gang was then started filling sacks with gravel and placing them shingle fashion, starting at the bottom. First a layer was made of burlap sacks and then two layers of cement sacks on top. These sacks also extended well over the top of the wall previously described. It is believed that the work thus done offers ample protection against future storms until the water level has been lowered during the coming irrigation season to such a point that permanent repairs can be made. Repair work proceeded until the 17th when work was practically stopped until the 21st due to a severe blizzard and heavy snowfall. The work was finished on April 27.

The total cost of making the necessary temporary repairs was $2,600, distributed as follows:

Labor, breaking and placing concrete slabs	$ 100
Labor, hauling and placing gravel fill	860
Labor, filling and placing sacks of gravel	940
Material, cost of sacks used	700
Total cost	$2,600
Number of loads of gravel used	470
Length of haul, mile	1
Unit cost per load	$1.83
Total man-days labor	261
Total team-days labor	146

Discussion by Mr. Weiss.—In August, 1916, a similar failure of a portion of the paving of Minatare Dam occurred, though of a much less serious nature. The cause of the 1916 failure was thought to be primarily the settlement of the dam foundation, which was noticed during the time of the building of the dam, and caused a series of horizontal cracks in the paving. In some places these cracks became sufficiently enlarged to permit the wave wash to suck some of the fine material from under the blocks, thereby partly undermining them, and as this process advanced the facing blocks finally lost sufficient support, which condition resulted in the opening of extended horizontal cracks, and with the opening of these conditions rapidly became reciprocally worse, until failure occurred.

Following the 1916 failure numerous tests were made over the entire facing, especially near the places where these horizontal cracks had developed, to determine the extent and location of hollows which had formed or were in process of forming. A grouting machine was then installed, together with an air compressor, and these defective places in the facing were tapped with holes and grout forced into place to refusal. The broken portion of the pavement reported in August, 1916, which extended from station 28 + 90 to 30 + 80, was replaced after the close of that irrigation season, and no further deterioration or damage was noted on the facing until the break of April 10, 1920, occurred.

The repair of the present break is thought to be a simple matter of replacing the broken paving with slabs of the original thickness, 10 ft. in width and either of continuous length or with hinge joints horizontally placed, as originally built. This paving should be reinforced with quarter-inch square bars, spaced 6 in., center to center, in the middle of the slab, reinforcement being placed both ways, horizontally as well as along the slope. Under the joints it is suggested that concrete sills be placed 6 in. in thickness by 12 in. in width, to prevent the further removal of fine material by sluicing from underneath. This means of prevention was adopted in the case of the Pruitt Reservoir, illustrated on page 103, volume 77, Transactions American Society Civil Engineers, 1917.

An effort will also be made to locate any further hollow places which may have formed under the paving elsewhere, particularly where any other cracks are noted through which the sand may have been drawn by the wave action.

The behavior of the Minatare Dam facing would suggest rather strongly that wherever it is desirable for any reason to omit the screened gravel layer between the concrete facing and the body of the dam the facing should be reinforced and placed in continuous layers from bottom to top or in slabs of not less than 20 ft. length with hinge joints, and that the joints between these courses be underlaid with concrete stringers or ribs, also reinforced, which would prevent the sucking of sand from under these slabs. It is very seldom that unscreened gravel [illegible] contains a sufficient proportion of coarse material [illegible] to effectively resist the wave wash, [illegible] even a temperature crack, becomes [illegible] the underlying material is in [illegible] resulting suction. Furthermore [illegible] develop, due to the settling of the [illegible] was the case at the Minatare [illegible] a common condition throughout [illegible]

There has been so far practically [illegible] this project with dam facings [illegible] screened material overlaid with screened [illegible] top of which was placed loose rock paving. This method of paving has proven an excellent protection at the [illegible] finder Dike, and also at Lake Alice, [illegible] pairs have been necessary since [illegible] built approximately seven years ago. It is [illegible] from our experience at the Minatare [illegible] that the [illegible] of such concrete paving may be overcome [illegible] by adopting the method of building [illegible] from the bottom to the top of the facing, reinforced [illegible] with steel and with concrete ribs placed under the [illegible] these courses. This protection would probably be unnecessary, however, where a 12-in. layer of screened gravel or spalls is placed as a foundation course for the [illegible] facing.

Results of Water Waste Survey at Boston

As a result of a recent water waste survey at Boston a saving of 955,000 gal. in a week day average daily consumption of 6,582,540 gal. was effected. The survey was made in the Charleston District, which has a population of approximately 34,500, a pipe mileage of 19 and an unusually large industrial consumption. The district is thickly settled and entirely metered. The following notes are taken from a paper by F. A. McInnes, Division Engineer Sewers and Water Basins of Boston, presented at the recent convention of the New England Waterworks Association.

The leaks located and stopped were as follows:

	Amount of waste Gal. per day	Outlet
Broken 2-in. pipe	[illegible]	[illegible]
Blown 8-in. joint	11[illegible]	[illegible]
Broken ⅝-in. service	[illegible]	Flowed into sewer
Broken ⅝-in. service	[illegible]	Underground
Broken ⅝-in. service	[illegible]	Flowed into sewer
Broken ⅝-in. service	87,[illegible]	[illegible]
Blown 6-in. joint	[illegible]	Flowed into sewer
Split ⅝-in. service	[illegible]	Underground
Broken 1¼-in. service	[illegible]	Underground
Split ⅝-in. service	27,000	Underground
Hydrant not seated	[illegible]	Underground

One 10-in., one 8-in., two 4-in. and two 3-in. meters were found to be under-registering, some of them seriously. No case of unauthorized use of water was found.

The week day average daily industrial consumption (including schools, armories, factories, power plants, gas works, dairies, sugar refineries, railways and Navy Yard) was noticeably large, amounting to 4,424,765 gal. or approximately 128 gal. per capita—four customers only, were responsible for 3,832,000 gal. or more than three-quarters of the whole. In one of these cases there is every reason to suppose that a large waste helps to swell the bill.

Allowing an unavoidable waste of 3,000 gal. per mile of pipe per day, the present domestic daily per capita consumption of the district, as determined by the survey, is 32 gal.

The method of work was essentially the same as that used successfully for many years in Boston, with the difference that the portable pitometer inserted in the pipe through a 1-in. corporation cock, supplanted the permanently located Deacon meter and gave greater flexibility of operation.

The district, approximately one square mile in area, was divided into 12 sections the largest of which contained about 40 blocks. The average daily consumption of each section was determined by taking the mean of two 24-hour measurements, the flow into the section being through one pipe, that into which the pitometer was inserted, and the section being completely isolated from the surrounding distribution system by the closing of all gates around its boundaries, and if the minimum night rate was found to be more than one-half the average daily rate, it was assumed that avoidable waste existed and the section was sub-divided to further locate such waste. This work was done at night during the period of least draft; the flow into the [illegible] section was first measured, then the area of the section was [illegible] decreased by [illegible] and the [illegible] the amount of water used in each block and a leak of any considerable size was quickly apparent. [illegible] that it might be repaired. [illegible] perhaps the most successful was the use of a steel rod driven down to the pipe at intervals of about [illegible] ft. and listening with an aquaphone at the end of the rod. [illegible] was avoided.

The survey was begun May [illegible], completed July [illegible]. It was made by the Pitometer Co., New York.

Rules and Suggestions of Terre Haute Water Co. for Its Firemen and Boiler Room Helpers

Instructions for pumping station operation that have given excellent results for the Terre Haute Water Co., one of the most progressive public service companies in the country, were given by Mr. Dow R. Gwinn, President of the company, in a paper presented Sept. [illegible] at the [illegible]th annual convention of the New England Waterworks Association. These rules contain so much that is suggestive and valuable that we are reprinting them below.

The Terre Haute Water Co. takes its supply from the Wabash River and is a direct pumping plant. For pumping into the distribution system there is a 10,000,000-gal. vertical triple expansion, and a [illegible] vertical compound and also several smaller pumps. For delivering to the sedimentation basin there is a centrifugal pump operated by a compound high speed engine connected with a rope drive. Steam is generated in water tube and fire tube boilers with hand firing. The pumps work against 70 lb. domestic pressure and 125 lb. fire pressure.

The rules and suggestions for firemen and boiler room helpers follow:

For Firemen.—Upon coming on watch, immediately observe steam pressure, water level in boilers, and general conditions. Blow down water from water column to be sure it is working properly.

All coal and ashes are to be weighed and the time of coal loading to be entered upon report sheet; the back weighing to be made at end of each shift and the back weight to be charged to the fireman coming on duty.

After boilers have been cleaned and in service four days they are to be blown down once each day thereafter at about 8 or 9 o'clock in the morning. The engineer on watch is to be called at this time and the extent and method of blowing down is subject to his approval.

Flues to be blown twice each day, on the first and second shift, as soon as convenient after coming on duty.

Any defect in any boiler, steam pipe, feed pump, or any apparatus in the boiler room should be reported at once to the engineer on watch.

In the event of heavy call for steam, such as a large fire, and the fireman thinks he cannot hold steam with the boilers in use, he should report to the engineer at once.

Firing Methods.—Although it is not intended to lay down any hard and fast rule for firing, nor to discourage individual method if such method can be shown to be better than these, yet it is thought that a very good method of procedure is as follows:

Keep grates fairly clean, and preferably so by the use of shaker grates. (Although it is known that with some coal and conditions of fire it may be necessary to clean with a [illegible] and hoe.) Fire at rather frequent intervals, say 7 to 10 minutes. Firing at long intervals, say, 12 to 15 minutes, is not good practice and is not approved. [illegible] and quantity fired so that the fires will not burn down dead and leave air holes at the time of next firing. In general the least damper opening and draft you can use will be found most economical. When the draft is so great that fire burns down in holes, then heat is lost simply by heating the air drawn in at such points and does no good whatever.

It is suggested that the fireman learn to notice the draft gauge just as he observes the steam gauge. It will indicate the need of shaking grates, the presence of air holes in fire when they burn too low, etc.

It is recommended that the firing be done as rapidly as possible consistent with the proper spreading of the coal, so that the doors will be open as short a time as practicable; also when about to clean by the slice and draw method, all tools that are to be used should be provided right at hand before beginning to clean, and put away after the cleaning is finished and the door shut.

Firemen will answer the emergency call bell by reporting at once to the engineer.

If a fire alarm catches you with dirty fires, it is probably best to shake grates or clean at once and to do so as quickly as possible, even if you cannot take time to make the cleaning as complete as usual.

It is requested that the firemen, so far as is consistent with their other duties, shall keep the fire room, coal shed, etc., in a neat and tidy condition; this also applies to the toilet room always leave it in at least as good condition as you find it

Firemen will sign their name to the recording steam charts on space that he is on duty.

For Boiler Room Helpers.—Follow our usual practice as to washing and cleaning boilers. As a general thing, about three weeks is a proper length of run wash out all scale and mud, then pick off all scale that can be gotten at, and wash out again. In the case of the Stirling, the tubes may be turbined each cleaning, or the turbining may be omitted if conditions justify it.

Inspect boiler carefully for defective tubes, tubes needing rolling, bags in shell, or any leaks at any point. Also note the presence or absence of oil or grease in boiler and report to chief engineer. The tubes of tubular boilers should be brushed with wire brush when these boilers are cleaned.

Boiler setting should be frequently inspected by the candle method for air leaks; fill any cracks or defects with a mixture of asbestos and fire clay.

The condition of baffles should be noted when Stirling boiler is cleaned and repairs made as needed.

The non return valves provide against return of steam to a boiler that is being cleaned; follow present practice in seeing that all valves on the feed or blow-off lines that can communicate with any supply of steam or hot water are closed. Also, until some other method is provided, wire the wheels of such valves so the valves can not be opened.

If the cleaning work takes you into a boiler alone, you should always notify the engineer on watch or other responsible party of the fact, and of which boiler you are working in.

Fusible Plugs.—When a boiler is being cleaned, the fusible plug should be inspected and cleaned, both on the outside and inside; if it seems defective, it should be replaced by a new one.

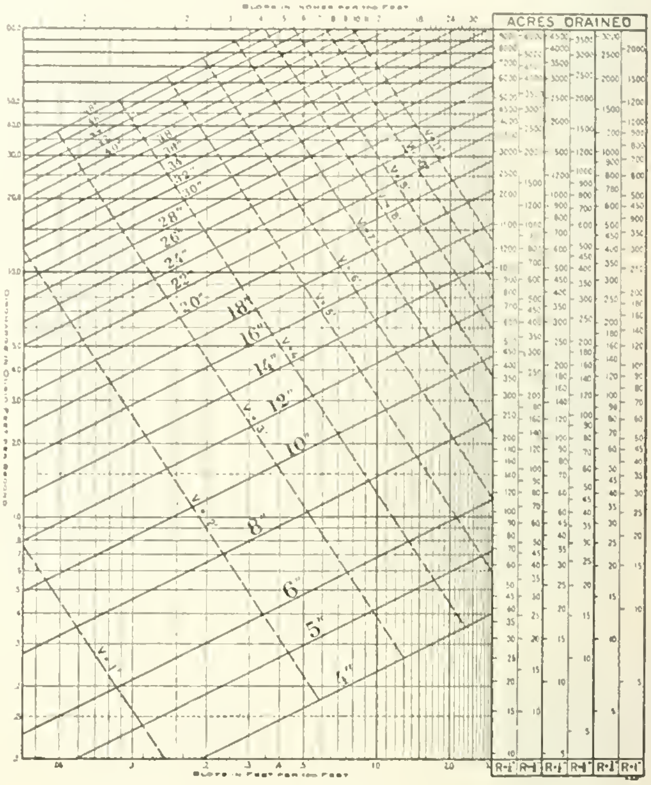
U. S. Geological Survey Uses Fire Towers in Surveying.—Recently topographic engineers of the U. S. Geological Survey, Department of the Interior, while working in the heavily timbered area of northern Maine, saved great expense by making observations from the numerous steel lookout towers erected by the Maine Forestry Commission to aid in protecting the timber from fire. These lookout towers range in height from about 40 to 70 ft., and in each of them a watchman is stationed day and night during the summer and fall. The Government surveyors found that these towers make admirable observing stations, and by using them they were able to do work in five weeks which would otherwise have consumed four or five months. In this way they saved several thousand dollars and were able to cover a larger area than they could otherwise have covered with the funds available.

Annual Meeting of Iowa Section Am. W. W. Assoc.—The Iowa section of the American Water Works Association will hold its sixth annual meeting at the University of Iowa at Iowa City on Friday and Saturday, Nov. 5 and 6. Included in the Iowa section this year are members of the water works association in Wisconsin, Missouri, Nebraska and South Dakota. Inasmuch as the section now embraces more than the state of Iowa it is possible that the name will be changed at the approaching meeting. George E. Shoemaker, Waterloo, is chairman of the Iowa section, Frank Lawlor, Burlington, is vice chairman, the two trustees are Robert B. Wallace, Council Bluffs, and R. B. Ross, Dubuque, and the secretary-treasurer is Prof. Jack J. Hinman, Jr., of the University of Iowa faculty.

New Formula for Flow of Water in Drain Tile

A new formula for the flow of water in drain tile derived from experiments in which 824 separate tests were made, is published with a description of the tests in Bulletin No. 854 of the U. S. Department of Agriculture. D. L. Yarnell, Senior Drainage Engineer, and Sherman M. Woodward, Professor of Mechanics and Hydraulics, State University of Iowa, are the authors.

The principal feature of the equipment for making the experiments was a wooden flume about 570 ft. long, in which the tile was laid in earth exactly as drains are installed in the ground. The flume was adjustable to any grade up to 1.50 per cent (s=0.015), without disturbing the tile. The depths of flow were observed by piezometer tubes hung on the side of the flume.



Discharge Curves for Drain Tile Based on Formula V = 138 R 2/3 S 1/2.

Experiments were made with all the usual commercial sizes of tile, both of clay and of concrete, from 4 to 12 in. inside diameter. Nine grades were used, from 0.05 to 1.50 per cent, for each size and kind of tile. For each size, except for some of the smaller sizes, tests were made for depths of flow of one-fourth, three-eighths, and one-half the terminal diameter of the tile, and other depths ranging from half full to full by successive increases of 5 per cent of the diameter.

The water for making the tests was used over and over again, returning from the end of the line to a pump which lifted it to an overhead supply tank.

The investigations were made at Arlington, Va., in 1916 and 1917, and the tests were made by D. L. Yarnell.

The report upon the investigation of flow in drain tile includes a detailed description of the equipment and methods used and the tabulated data from the experimental work. The results deduced from the data are shown graphically, the method of developing the curves being explained. The formulae now in general use for computing velocity in tile are discussed and comparison is made with the new formula presented. A diagram is given showing discharge capacities based upon this formula, covering sizes from 4 to 48 in. tile, and grades from 0.04 to 3.00 per cent.

The new formula as finally developed is

$$V = 138\ R^{2/3}\ s^{1/2}$$

in which

V = mean velocity of the water in feet per second.
R = mean hydraulic radius.
s = hydraulic grade or slope.

The following general [illegible] a detailed study of all of the [illegible]

(1) That the value of coe[illegible] Kutter formula, as obtained by [illegible] at any depth of flow less than [illegible] ply to that drain or pipe whe[illegible]

(2) That the exponent of [illegible] In other words, the loss of hea[illegible] power of the velocity and [illegible] many authorities.

(4) That the exponent of [illegible] is 2/3.

(4) The Chezy formula gi[illegible] in a pipe flowing one-half full [illegible] grade constant. The experi[illegible] disprove this commonly accept[illegible]

Some Questions on House Hot Water Systems That Waterworks Officials Should Be Able to Answer

Many inquiries are made [illegible] conditions existing in the [illegible] the direct province of the department. [illegible] at the recent convention of the New England Water Works Association, Mr. D. A. Heffernan, Superintendent of the Water Department of Milton, Mass., gave [illegible] some of the more frequent questions which a water works official is liable to encounter, and which he should be able to answer. The matter following relating to the house hot water system is taken from his paper.

Rumbling in Boiler.—Several causes [illegible] contribute to rumbling in the range boiler, among them being the following:

Partial or entire stoppage of boiler supply, house service pipe or cold water pipe on range connection.

Air pocket in water front.

Boiler tube too small.

Range flow pipe sagging or having wrong pitch.

Too great heating surface.

A partial stoppage of supply to the house boiler or water front will permit water to be supplied to the water front as fast as hot water may be drawn from a faucet and consequently steam may form. If a range flow pipe pitches down to the water front or if the pipe sags, the circulation of hot water is retarded and even stopped momentarily. The water passing through the front becomes overheated, bubbles of steam form and as these come in contact with the cooler water in the boiler they condense suddenly, producing a partial vacuum which the water at once attempts to fill, thereby causing the rumbling noise.

Water boils at 212° F. at atmospheric pressure. Under 60 lb. it boils at 300° F. Hence, if water is heated to 210° F. under this pressure and the pressure suddenly reduced by opening a fixture, it may be seen that there will be more heat in the water than is necessary to boil it at the reduced pressure resulting in its instantaneous vaporization and causing the rumbling sound. This trouble may be overcome by reducing the heating surface, increasing the size of the boiler, the heating of radiation from the boiler or by adding circulation.

Bursting or Collapse of Boiler.—Range boilers collapse through the formation of a partial vacuum inside of the boiler and insufficient strength of the shell to withstand the atmospheric pressure. This vacuum is made by siphonage of the boiler. In the case of a pressure boiler conditions are very favorable for this to happen. The boiler tube which extends almost to the bottom of the boiler forms the short arm of the siphon while the boiler supply reaching to the service pipe and street main represents the long arm.

A siphon will operate by a flow of water to the boiler supply. This may be caused by closing of the [illegible] waste cock, which will allow the water to flow through the waste hole, or by a break in the boiler supply pipe, service pipe or even the street main. When the siphon begins to operate the contents of the boiler are drained to the bottom of the boiler tube, unless means are taken for its prevention. It is practically impossible to siphon a boiler supplied by tank pressure because the supply comes from above.

There are several ways of preventing boiler siphonage by [illegible]

[illegible]

Expansion of Water Front.—[illegible]

Dirty Hot Water.—[illegible] Hard water will not act in this manner. [illegible] of an iron front if a little [illegible] of lime is kept in the water until a protective coating is formed it will be found to be a remedy. Galvanized piping in the hot water system or sediment drawn from the boiler is another reason. If the boiler is supplied from an uncovered tank in the attic neglect of cleaning the tank will contribute its share of supplying dirty water. A galvanized iron boiler is another frequent cause.

Cold Water from Hot Water Faucet and Vice Versa.—It often happens when water in the boiler is overheated that it will cause the hot water to back into the cold water piping. When the water is heated to this extent the upper part of the boiler fills with steam, the expansion of which drives the hot water into the cold water pipes.

When cold water is drawn from a hot water faucet it may be due to the boiler tube having rusted off or been omitted, or to the fact that the siphon hole is too large. Any of these three causes may result in the top of the boiler filling with cold water permitting it to enter the flow pipe from the boiler.

Air Lock.—Air lock is caused by the collection of air at high points on the system of hot water piping when such points are not vented. The air was in the water when it entered the water front where it was liberated by the heat. This condition occurs only in systems under low pressure. If the water pressure is strong enough the air will be forced out as fast as it attempts to accumulate. An expansion pipe run from the high point on the piping and carried to the supply tank will prevent the accumulation of air.

Consumption of Water and Average Receipts at Council Bluffs, Ia.—The consumption of water at Council Bluffs, Ia., in 1919 and the receipts for same are classified as follows in the last annual report of the Board of Water Trustees:

[illegible] metered)	[illegible]
[illegible] metered)	[illegible]
[illegible] water works plant	[illegible] gallons
[illegible] (unmetered)	[illegible] gallons

The classification of "non-productive" includes water consumed by the city at the city buildings, fire stations, fire protective service, flushing sewers and streets, public drinking fountains and watering troughs, together with the losses in the distribution system due to leakage in mains and services and losses from defective meter registration. The cost per 1,000 gal. of water pumped is $.0926, or slightly less than for the previous year, and the average receipts per 1,000 gal. from meter and flat rate consumers is $.125, as against $1.126 for 1918.

Cold Weather Troubles of Water Departments

Information regarding the effect of the cold weather of 1917-18 on water works operations has been collected by a committee of the American Water Works Association, and formed the basis of a report presented at the Montreal convention of the association. The committee received 85 replies in response to its questionnaire. Extreme low temperatures prevailed throughout the country during the winter of 1917-1918. Unfortunately, the replies to the questionnaire seldom gave temperature where trouble was experienced and did not indicate one close relation between trouble and temperature that one might expect. Trouble was experienced in comparatively high temperatures in some localities and none reported at low temperatures in others, without any explanation of this unusual condition. In few cases was there any mention as to the depth of snow. Nearly all reported an increase in consumption during the cold period.

The data in regard to depth of covering were interesting but not conclusive except in emphasizing the need of giving special study to local conditions. Pipe having a covering of 51 in. of coarse gravel froze while pipe having only 28 in., laid in wet ground, escaped. The size of the pipe and circulation being the same, it is reasonable to suppose that the nature of the covering material accounted for the difference. The question of covering should receive the careful consideration of the local management.

The data in regard to thawing were more complete. Forty-six replies reported in more or less detail the use of electrical current in thawing; 22 reported as to other means, steam, etc. Important details, however, were lacking in many cases. In 53 of the cases the information was not comparable. Steam was used successfully in a number of cases.

The majority of replies clearly favored the use of electrical thawing and indicated that this method afforded advantages as to both cost and efficiency. The cost data were incomplete, only a few replies giving details as to length or size of pipe, time, etc. The cost for service work ranged from $1.90 to $139 per service; and the time from 30 minutes to two days. In general, it may be said that the expense of thawing a service was under $9 and the time required less than one hour. In the majority of the cases reported the current was taken from the local lighting company; fourteen water companies did their own work of thawing; and in five cases the work was done by plumbers. The current used ranged from 5 volts and 150 amperes to 125 volts and 600 emperes. Storage batteries were used to some extent. There is a possibility that the use of electrical current may damage the pipe connections.

Many automobiles were converted into effective thawing outfits, and there are undoubtedly possibilities in this line. The committee would recommend a generator operated by a gas or oil engine, mounted on an iron frame, equipped with rheostat, automatic circuit breaker, voltmeter, ammeter, cable, etc., all to be mounted on a trailer or sleigh, and further suggests the use of a current of from 30 to 50 volts and 130 to 400 amperes. There should be a rheostat control to permit increase or decrease in the voltage without interfering with the proper operation of the outfit. By proper manipulation, such an outfit should serve both for service work and reasonably sized pipes, and, if properly and carefully handled, would be safe and effective. It was suggested that where high voltage current was available, an alternating current transformer be held in reserve so that if more convenient, current could be taken from the power company. The manipulation in this case should be entirely under the control of the power company. It must be borne in mind that in the use of any electrical current for thawing there is definite risk and that care and common sense must be exercised.

The greatest cold weather trouble probably comes from frozen services, at least the greatest "kick" comes from this source. The service pipes are seldom laid as deep as the mains and more often with much less covering, exactly the reverse of what it should be. Not infrequently the tap is made near the top of the main and the gooseneck is perhaps 1 to 8 in. above the main. Services should have more covering than the mains and should be carefully inspected, especially if laid by plumbers. A main or service that has once given trouble should be lowered to prevent a repetition of it.

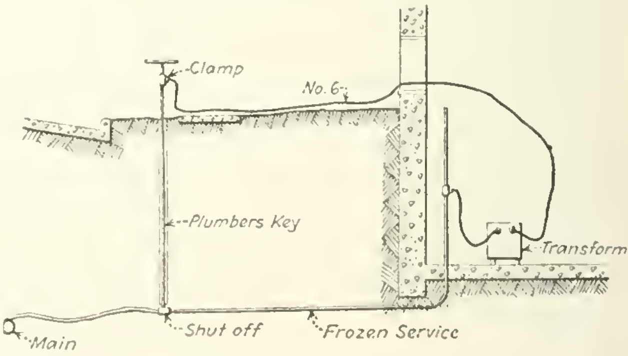
A frozen service is more or less inconvenient but a hydrant out of commission creates a serious risk. Hydrants should receive special attention and every hydrant on the system should be inspected late in the fall. The drip should be open, if the hydrants are set so they can drain. If set in water, the drip should be plunged and the hydrants pumped out. Those on dead ends should be packed. Where it is necessary to take these precautions, hydrants should be inspected frequently. There should be a rigid rule to prevent unskilled or curious people opening hydrants during cold weather "to see if water will run," a not infrequent cause of trouble.

Frozen hydrants were reported successfully cleared by steam, hot brine, calcium carbide, alcohol or by building a fire about them. No information was given as to the effect of salt or carbide on the valves. Alcohol was reported as giving satisfactory results but it is rather expensive and since the Volstead Amendment might be considered unsafe, not, however, as unsafe as the practice of building fires. Ordinary hot brine will do good work. If the trouble is in the branch, salt and carbide are said to be effective.

Pipe-Thawing Outfit Operated from House Electric Service

A pipe-thawing outfit which can be operated from a 110-volt or 220-volt house service has been developed that may be operated safely without requiring great skill. A description of this outfit is contained in an article by H. S. Rush, Associate Professor of Electrical Engineering, State School of Science, Wahpeton, N. D., in a recent issue of Electrical World as follows:

The equipment consists of a 1.5-kva. transformer having 110-volt and 220-volt primary windings and a 16-volt secondary, 100 ft. to 125 ft. of No. 6 weatherproof copper wire in pairs for the secondary connections and 50 ft. of No. 14 drop cord for the primary connections. The current supply is obtained from a connection at the entrance cabinet of the house-lighting service, using the 220-volt connection where the service is three-wire. One secondary connection is made to the water pipe in the building and the other by means of a plumber's key attached to the shut-off cock at the street end of the service pipe.



Pipe Thawing Outfit Which Takes Current From House Service.

The transformer capacity of 1½ kva. has been found sufficient for ¾-in. and 1-in. iron and lead service pipes. The thawing time ordinarily ranges from ten to thirty minutes, which compares favorably with the former method using a 10-kva. to 15-kva. transformer connected to the 2,200-volt primary circuit. Should the service be frozen between the shut-off and the main the connection may be made to a neighboring shut-off.

The transformer used is of the ordinary core type having a core made of sheets of stovepipe iron. The laminations are 1¾ in. x 6¾ in. and 1¾ in x 9¾ in. The core is built up to a cross-section of 1¾ in. x 1¾ in., with the laminations dovetailing at the corners in groups of five. The opening through the core is 5 in. x 8 in. The primary winding consists of 520 turns of No. 12 magnet wire divided into two windings of 260 turns for paralleling when using 110 volts on the primary. The two halves of the primary winding are placed in series when using 220 volts. The secondary is made of 38 turns of No. 1

bare copper wire. The transform[illegible] ed in a wooden case with a hol[illegible] additional secondary turns may b[illegible] the secondary voltage if require[illegible] er is 8½ in. x 14 in. x 13½ in. h[illegible]

The current depends upon the [illegible] usually 80 amp. to 110 amp. on [illegible] amp. to 16 amp. on the primary.

How to Fill a Water Main Line

Useful suggestions on filling a [illegible] Mr. George H. Finneran, Superint[illegible] of Boston, Mass., in his paper, "A Pra[illegible] Waterworks Matters," presented at the [illegible] of the New England Waterworks A[illegible] this portion of his paper follows:

To the average workman filling a [illegible] monplace affair, but to the competent and [illegible] it is a very important matter. The important thing is to get rid of all the air. In ordinary distribution [illegible] hydrants are connected, this is not a hard matter as by opening one or more hydrants the main pipe is vented and the air allowed to escape as the water displaces it. In large transmission mains, air valves placed at high points in the grade line are the only means of letting out the air. There should always be at least one air valve of at least 2 in. in diameter in each section between gates and located at the highest point of the pipe line. If the grade line of the pipe is undulating the valve should be placed on every summit. If gates are located at high points it is well to have an air valve close to the gate on each side.

A man should be stationed at each valve in the section to be filled, with wrench or key to control the valve when the air is expelled and the water comes. Not every man is suitable for this job. The roar of the air, escaping from a large main has a bad effect on a nervous man and he is inclined to shut the valve before all the air is out. As the filling of the pipe nears completion the air and water rush out alternately caused by the breaking down of air pockets and surging of the water in the pipe. If the manhole in which the valve is housed should become filled with water these rushes of air and water are apt to cause violent splashes and consequent wetting of the man with the wrench. A timid man may desert his post or allow the wrench to become displaced on the air valve. It is a hard matter sometimes to replace the wrench on account of the agitated state of the water in the box or manhole and its increasing pressure. An experienced man can usually tell when the air is all expelled. The discharge becomes more uniform and the water loses its whitey, foamy appearance.

If there are small by-passes around the large gates the filling of the pipe should be done through one of them, always choosing the low end of the section. If there are no by-passes there is usually at least one connection of smaller diameter than that of the main to be filled. Fill through that. If there are no by-passes or connections, open one of the large gates a very little and admit the water very slowly from the lower end of the section if possible. It is usually a hard matter to open a large gate with the pressure on one side only. Care should be taken to avoid breaking the gear or the screw.

If the air is not completely driven out of the pipe it will find its way out somehow and it is very often the case that it works its way out through the top of a joint or through the stuffing box of a gate valve. This means in the case of the joint a weakening of the same and a leak starts then and there. It is not an unusual thing that when a large line is shut down and emptied or partially emptied to make repairs that not long after it is turned on a leak is reported in the street over the line. This happens notwithstanding efforts to have the line properly filled, showing how difficult it is to rid the pipe line of all the air. Joints are often blown out by air.

The collapse of air pockets in the pipe sometimes produces powerful concussions which have a bad effect on the pipe line and cause a movement in the same at some weak point. It is therefore of great importance that the utmost care be exercised in filling pipes. Do it slowly. If possible, let it dribble in. The trouble is usually caused by impatient men who will not wait for the line to fill slowly.

Further Tests of Unaflow Pumping Engine*

By C. A. [illegible]

[illegible]

The first "Unaflow" pumping engine [illegible] described in this paper was designed primarily for experimental purposes with a view to determining:

1. The permissible speeds for reciprocating pumping engines of this type.
2. The actual [illegible] of the "Unaflow" engine over [illegible] at permissible reciprocating engine speed.
3. Its efficiency when operating at these speeds.
4. Its duty or useful work per 1,000 lb. of steam under various operating conditions.

With these objects in mind it was decided to design, construct, operate and test a single-cylinder horizontal crank and flywheel "Unaflow" pumping unit of the extended type having a nominal capacity of 3½ to 4,000,000 gal. per 24 hours.

The Commissioner of Public Works of the city of Buffalo, N. Y., upon request, gave permission for the installation of such a unit in the Porter avenue water works pumping station of that city.

This pumping engine has a steam cylinder 14½ in. in diameter by 21 in. stroke, directly connected at its outboard end, through an extension of its piston rod, to one double-acting pump having a plunger 9 in. diameter by 21 in. stroke, though the pump was so designed that plungers up to 11 in. could be installed if desired for experimental purposes. With the 9 in. diameter plunger, and operating at a speed of 210 r.p.m., its normal capacity is [illegible] gal. per day. When completed and installed the pump suction was connected by a pipe about 60 ft. long to the same pump well or conduit that supplied the other pumping engines in the Porter Ave. station, the suction lift being approximately 15 ft. The water pumped was discharged back into this well through a pipe provided for that purpose and any desired water pressure was maintained by throttling a gate valve in this discharge main.

For convenience in testing, a surface condenser in the discharge line and an independent air pump were used. In trying out the various features of the installation, 35 or 40 tests of various kinds were made, some of them rather unusual, for instance, operating a single plunger pump at 735 ft. per minute piston speed. During these tests, only the station steam pressure was available. This varied from time to time from 200 to 225 lb. gauge, superheated about 10 to 20° F. at the engine. After a part of the tests had been made, an independently oil fired superheater was connected to the steam line, and different steam temperatures were thereafter readily obtained. Before the tests were commenced all instruments and weighing apparatus were carefully calibrated.

On account of the size of the unit and facilities for testing a uniform period of two hours was adopted for each test, and —with few exceptions—all of them extended over this period. The steam for operating the independent air pump was not charged against the engine.

The engine frame was the enclosed type; the mechanical lubrication was flow and splash; the cylinder lubrication was positive. There have been no lubrication troubles of any nature, either in the bearings, running parts or steam cylinder. A thorough examination after the engine had been in service for some time showed the main and other bearings to be in first class condition, with no appreciable signs of wear. There have been no hot bearings during the operating life of this engine. The machine oil used was the oil ordinarily used at the Porter Ave. pumping station on the slow running 20,000,000 gal. vertical triplex expansion pumping engines in that station. The examination of the steam cylinder and piston showed them to be in excellent condition, the running surfaces well glazed over and polished, with no indication of abrasion either on the surface of the piston or in the cylinder at the exhaust ports.

The general principle of the "Unaflow" steam engine, from which it derives its name, is that the steam flows in one direction through the steam cylinder, ordinarily being admitted through the heated head at each end and exhausted at a point most distant from the point of admission. There is no reversal of steam over its own path, high compression is obtained, and initial condensation is practically eliminated, even with short cut-off, with the result that high economies are developed in a single cylinder engine of this type.

---

*From a paper presented Sept. 8 at the [illegible] annual convention of the New England Water Works Association.

[illegible] Engineering and Contracting, July 9, 1919.

Below are given condensed tabulations of 24 different tests:

Three tests were made, March 23 and 24, 1920, particularly for the purpose of ascertaining the per cent of slip and the relative duties when operating with normal m.e.p. in the steam cylinder with one-third overload and with two-thirds overload. The overload conditions were obtained by throttling the discharge gate-valve and increasing the discharge pressures, all other conditions—such as speed, steam pressure, vacuum, etc.—remaining as nearly constant as possible. The diameter of the pump plunger was 11 in. and the diameter of the pump plunger-rod was 3 in. The useful water-horse power was approximately 90 per cent of the steam-indicated horse-power in each case.

The duty stated is the duty in million footpounds per 1,000 lb. of steam, and is calculated from plunger displacement.

It is perhaps unnecessary to call attention to the fact that the unit is comparatively small, and that considerably better results may be anticipated from larger ones.

	Date of trials		
	Mar. 23.	Mar. 24.	Mar. 24.
Steam pressure at throttle, lb. gauge	220.0	218.0	220.0
Steam temperature at throttle, deg. F.	562.4	562.5	569.0
Superheat at throttle, deg. F.	167.0	167.7	173.0
Vacuum, in. mercury	27.0	27.5	27.3
Total head, ft.	153.0	195.6	251.7
Revolutions per minute	150.7	149.6	152.0
Duty, million footpounds	146.1	147.2	150.1
Average m.e.p. (lb.)	48.5	61.4	78.3
Indicated h.p.	103.0	132.0	171.0
Steam per i.h.p. hour (lb.)	12.2	12.1	11.9
Gal. per min. pumped (p.d.)	2,410.0	2,390.0	2,430.0
Gal. per min. pumped (cal. noz.)	2,370.0	2,340.0	2,360.0
Slip (per cent)	1.7	2.1	2.9
Av. velocity through pump valves, ft. per sec.	3.4	3.4	3.5
Duty, average of three tests, mill. ft. lb.	....	....	147.8
Slip average of three tests, per cent	....	....	2.2

It will be noted that there was an apparent slight increase in duty as the mean effective pressure in the steam cylinder was increased, but the results, being so nearly alike, indicate a very flat economy curve.

For the purpose of checking the relative steam consumption and duties at different mean effective pressures in the steam cylinder another series of tests was made during which the steam pressures were lower, the amount of superheat much less and the vacuum in the condenser somewhat lower, due partly to barometric conditions, for the barometer readings averaged 29.3 in.

An 8-in. plunger had been substituted for the 11-in. plunger and considerably higher water pressures in the pump were maintained. The following is a summary of these tests:

	Date of trials		
	Aug. 25.	Aug. 25.	Aug. 28.
Steam pressure at throttle, lb. gauge	205.0	209.0	216.0
Steam temperature at throttle, deg. F	426.0	428.0	430.0
Superheat at throttle, deg. F.	36.0	36.0	36.0
Vacuum, in mercury	26.5	26.3	25.8
Total head, ft.	249.5	302.5	366.7
Revolutions per minute	210.0	207.5	208.0
Duty, million footpounds	128.3	131.5	132.0
Average m.e.p. (lb.)	39.3	46.0	57.8
Indicated h.p.	118.8	137.8	173.5
Steam per i.h.p. hour (lb.)	13.6	13.5	13.3
Efficiency, per cent	88.0	90.0	87.2
Capacity per minute (plunger dis.)	164.6	1,630.0	1,633.0

During these three tests the operating conditions were maintained as nearly uniform as practical, excepting that the mean effective pressures in the steam cylinder were changed by increasing the discharge pressures in the pump.

The duties obtained confirm the results of the previous tests in that they show a slightly better economy for the higher mean effective pressures in the steam cylinder, but again the difference is so slight that it confirms the flat economy curve characteristics of this type of steam prime-mover.

No proper calibrated nozzles were available for measuring the water pumped during these tests, so no acceptable slip tests could be made.

During the months of November and December last a number of tests were made, and the results of some of them are given in Table 1.

During the last test the engine exhausted against atmospheric pressure, i. e., high pressure, non-condensing. Test No. 12 gave a steam consumption of 11.4 lb. i.h.p. hour.

At all times during its operation the engine was under the control of its variable speed governor. The results of all of these tests indicate that the permissible speeds of this type of pumping engine are much higher than considered advisable for familiar types of crank and flywheel pumping engines. The results as to steam economy speak for themselves; they indicate higher economy for higher speeds and temperatures.

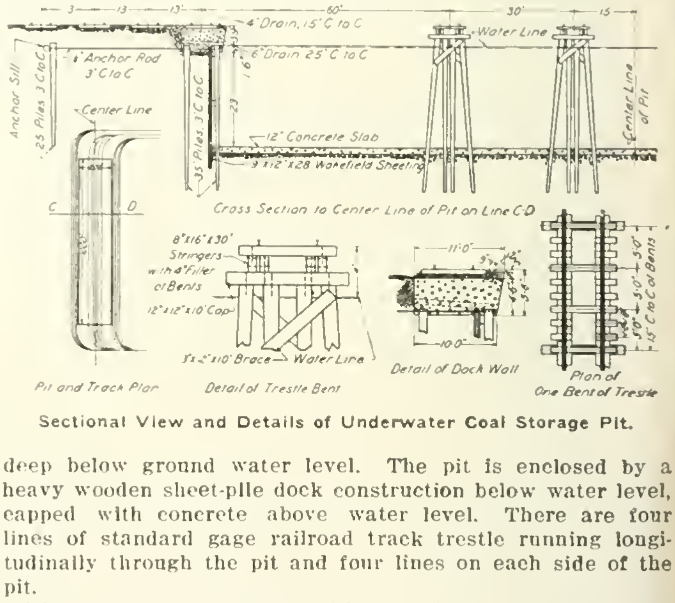
TABLE I.

Test No.	R.P.M.	Steam pressure by gauge.	Superheat, deg. F.	Total water pressure.	Duty.
1.	98.6	217.0	0.0	96.3	101.5
2	124.3	218.7	7.0	96.2	109.0
3	119.7	216.7	9.0	97.0	115.7
4	177.3	215.3	25.0	97.7	126.3
5	201.1	213.0	22.0	97.5	132.0
6	162.0	219.0	55.0	96.0	132.5
7	125.8	216.0	53.0	98.8	135.5
8.	150.1	217.0	50.0	97.2	133.4
9	177.0	216.0	52.4	98.0	138.3
10	200.2	215.0	58.0	97.0	141.0
11	173.6	214.0	91.1	95.2	153.6
12.	199.6	215.0	89.1	99.0	157.0
13.	99.0	216.0	17.0	116.0	110.0
14.	122.6	214.0	20.7	115.0	120.4
15.	118.6	210.0	27.4	120.0	127.5
16	176.4	210.0	30.0	120.0	131.0
17.	199.3	212.0	31.0	123.0	134.0
18.	198.4	221.0	39.0	97.5	91.0

Underwater Pit for Storing 100-000 Tons of Coal

An underwater coal storage pit having several interesting features has been built for the Standard Oil Co. The pit has a capacity of 100,000 tons and is located about 2 miles south of the shore of Lake Michigan at Whiting, Ind. It was constructed by the Great Lakes Dredge Dock Co., Chicago. The following particulars are taken from a recently issued publication ("Bituminous Coal Storage Practice") of the Engineering Experiment Station of the University of Illinois.

The storage basin consists of a pit 1,000 ft. long, 202 ft. wide, and 28½ ft. deep below yard rail level and 24½ ft. deep below ground water level. The pit is enclosed by a heavy wooden sheet-pile dock construction below water level, capped with concrete above water level. There are four lines of standard gage railroad track trestle running longitudinally through the pit and four lines on each side of the pit.



Sectional View and Details of Underwater Coal Storage Pit.

The pit was excavated with a 15-in. hydraulic suction dredge, which was hauled overland a mile and a half to the site; advantage was taken of the marshy conditions to excavate a sufficiently large area in which to float the dredge. The excavated material was discharged through pipes at a point 1,000 ft. away from the pit and the run-off water carried back to the pit through trenches; thus a sufficient supply of water was insured to keep the dredge afloat. Wakefield sheet-piling and dock-piling were then driven by means of two floating pile drivers, built on the site, and the concrete mass surrounding the pit at the water line was placed, special concrete mixers being mounted on railroad flat cars. The bottom of the pit was leveled off with the hydraulic dredge by means of a special mouth-piece, so that no point was more than 6 in. above or below grade. After the dredge had leveled off the bottom, a drag was used consisting of a heavy horizontal 12-ft. by 1-ft. timber fastened to a pile driver.

The concrete floor, 1 ft. in thickness, was placed in about 25 ft. of water over the entire floor area of 1,000 ft. by 202 ft., by means of a special tremie device, patented by the Great Lakes Dredge & Dock Co. By using this device, it was possible to place the concrete under pressure and to spread it uniformly over the [illegible] more than 3 in. off grade.

The unloading is done by d[illegible] or side dump) from the trestl[illegible] By means of the four tracks [illegible] those on each side, six trains [illegible] can be unloaded or loaded simu[illegible]

The four tracks in the pit [illegible] a trackage length of practically [illegible] purposes; in other words, litt[illegible] stalling one of these pits in [illegible] yard can have an underwater [illegible] acquisition of more land.

Some Cost and Operating Data for Small Waterworks

By D. D. [illegible]

Professor of Electric [illegible]

The following cost and operating data pertain to small waterworks equipment. They [illegible] with the preparation of B[illegible] No. [illegible] "[illegible] Waterworks in Indiana," Purdue [illegible] Experiment Station, and in a [illegible]

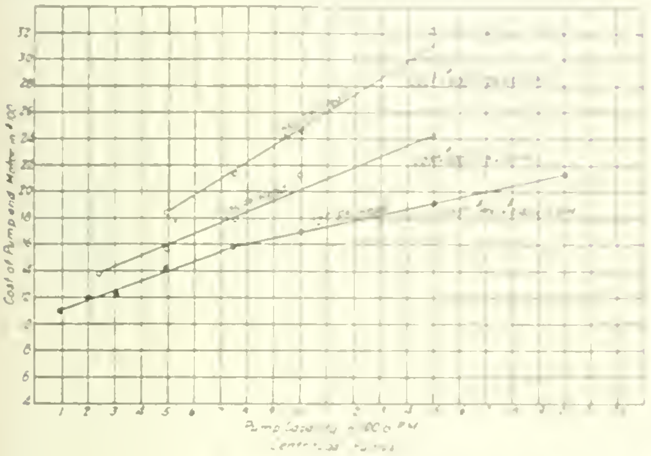


Fig. 1—Costs of Motor Driven Centrifugal Pumps

published in the issue of Engineering and Contracting for April 14, 1920.

Figure 1 shows cost data for centrifugal pumping units for 125-ft., 175-ft. and 250-ft. heads. These units include 3-phase, 220-volt, 1,800 r.p.m., squirrel cage alternating current induction motors, complete with hand-operated starting compensators, mounted on the same sub-base and direct connected to the pumps. The costs are F.O.B. works, and are as of May 1, 1919.

As cost equations are often more convenient for the engineer's reference handbook than tables or curves, such equations have been worked out for the graphs of Fig. 1. They are as follows:

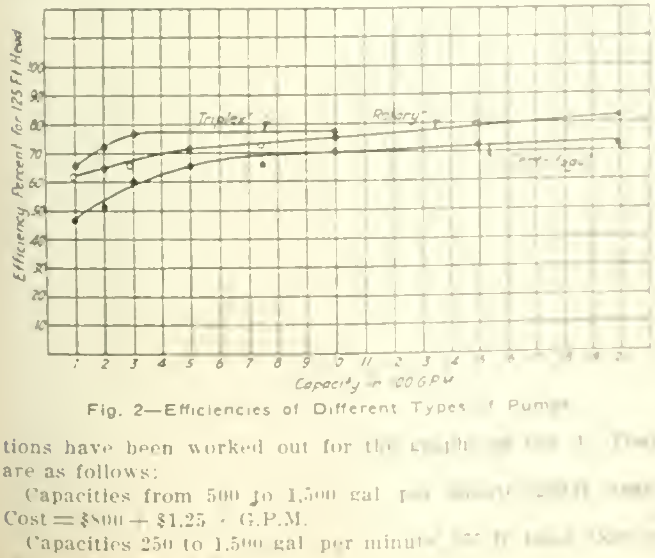


Fig. 2—Efficiencies of Different Types of Pumps

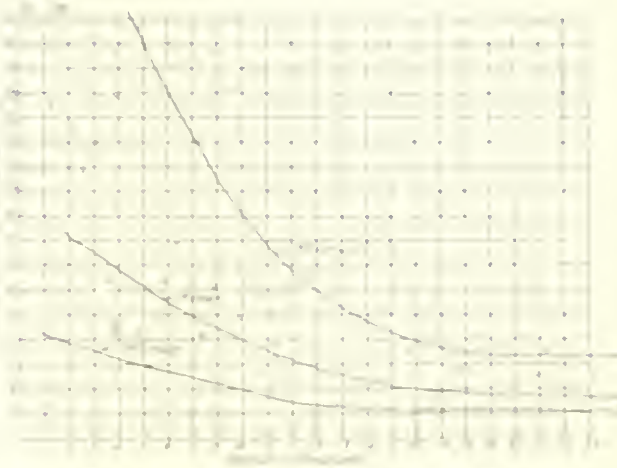
Capacities from 500 to 1,500 gal. per minute, [illegible] head: Cost = $800 + $1.25 × G.P.M.

Capacities 250 to 1,500 gal. per minute, [illegible] head: Cost = $800 + $0.80 × G.P.M.

Capacities [illegible] gal. per minute, [illegible] head: Cost = $[illegible] × G.P.M.

Capacities [illegible] gal. per minute, [illegible] head: Cost = $[illegible] × G.P.M.

[illegible]



[illegible] Fuel Consumption in Small Waterworks Plants

Capacities [illegible] gal. per minute, [illegible] head: Cost = [illegible] G.P.M.

Capacities [illegible] gal. per minute, [illegible] head: Cost = [illegible] G.P.M.

[illegible] with motor-driven compressors [illegible]

[illegible] G.P.M.

[illegible]

Capacities up to [illegible] gal. per minute, [illegible]: Cost = [illegible] G.P.M.

Capacities up to 2[illegible] gal. per minute, [illegible] ft. head: Cost = [illegible] G.P.M.

Steel elevated tanks, height to top of tank 100 ft., capacities 25,000 to 200,000 gal.: Cost = $[illegible] + $[illegible] capacity in 1,000 gal.

The tank costs are for the tanks erected complete and include everything except freight charges. The weights of these tanks and their towers are given by,

Weight in [illegible] tons = [illegible] capacity in 1,000 gal.

In Fig. 2 are shown the efficiencies of triplex, rotary and centrifugal pumps. These curves do not represent the efficiencies of just one pump of each of the different types operated under various discharge conditions, but are the efficiencies of lines of pumps of the several types, the efficiency of each pump in a given line being the best operating efficiency of that pump.

Fuel consumption and conservation are matters of prime importance today and in Fig. 3 is shown an analysis of the fuel consumption of a number of small steam operated waterworks plants in Indiana. It will be noted that in the small plants the fuel consumption reaches an almost prohibitive figure. Were these plants operated by electric motors receiving their energy supply from a central station of only moderate capacity, the equivalent coal consumption would rarely exceed 7 lb. of coal per 1,000 gal. of water pumped and in many cases fall below 3 lb. per 1,000 gal.

Mississippi Valley Waterways Asssociation Merged with Mississippi Valley Association.—A merger of the Mississippi Valley Waterways Association with the Mississippi Valley Association was effected at a meeting of the directors of these two organizations held at St. Louis Oct. 2, according to an announcement made by J. B. Morrow, managing director of the Mississippi Valley Association, with headquarters in St. Louis. Under the terms of the merger, James E. Smith, president of the Mississippi Valley Waterways Association, becomes head of the newly created Waterways Division of the Valley Association. It is understood that Mississippi Valley Waterways Association's program for river development will be carried out by the Waterways Division. As far as is practical, former directors of the original waterways organization will assist in functioning of the Waterways Division.

Oil Burning Boiler Plant of Lynn, Mass., Pumping Station

As a result of the coal situation in the past two years it was thought desirable to change to oil as fuel for the boilers of the main pumping station of Lynn, Mass. An interesting description of the installation was given, by Mr Reeves J. Newsom, Commissioner of Water Supply, Lynn, in a paper presented Sept. 8 at the 39th annual convention of the New England Waterworks Association. An abstract of this portion of his paper follows: The station is equipped with a 15,000,000 gal. per day turbine driven centrifugal pump, and two reciprocating crank and flywheel pumps, 10,000,000 and 5,000,000 gal. per day capacity, respectively, power for which is furnished by two 175-HP. boilers. There is also a motor driven centrifugal auxiliary pump of 3,750,000 gal. per day capacity, for which power is purchased from the local electric light company. As the consumtpion is about 9,000,000 gal. per day, it is essential that at least one boiler be in operation at all times in addition to the electric unit, and ordinarily all the pumping is done by steam using both boilers.

The coal problem has become very serious in two ways. At times coal is scarcely obtainable and last winter for several weeks it was necessary to depend on trucks coming through the deep snows from a city 20 miles distant to keep the pumps going. Then, too, the quality of the coal now on the market made its use very uneconomical. The station duty has dropped as much as 30 per cent at times, and in order to keep up steam there has had to be wasted unburned, through the ash pit, 18 per cent to 20 per cent on the average, and, at times, as high as 28 per cent of the coal fired. Combined with these facts has been the ever-rising price of coal from around $4 per ton to $16.50 at the present time.

A contract was made for oil at the equivalent of about $9 per ton for coal, and the price is guaranteed for 2½ years, and the delivery of the oil for five years. This contract is backed by a $10,000 bond, which is two-thirds of the cost of the oil burning apparatus, and the amount to be saved is such that if the oil company delivers oil for only a few months this city can change back to coal without loss.

The oil burning apparatus which is being installed consists of three principal elements, the storage tank, the combined pump and heater, and the burners, with connecting piping and auxiliaries.

The storage tank is of reinforced concrete, built in two separate compartments with a total capacity of 35,000 gal., or about three weeks' supply. A suction pipe comes from each compartment of the tank and runs to the pump inside the boiler room. These pipes are surrounded near the end by steam jackets which heat the heavy fuel oil so that it will flow. Pipes extending to the bottom enter the tank at the same points to which ejectors can be attached for removing water which may collect from time to time.

The pump to which the suction pipes are attached is of the double duplex direct acting type, mounted above the heater which is cylindrical in shape, the whole making a small compact unit. The heater is constructed like a surface condenser, the steam being inside the tubes and the oil flowing around them. In this heater the temperature of the oil is raisd to about 130° F.

From the heater the oil is pumped to the boiler front, where it passes through an auxiliary heater composed of another steam jacketed section of pipe which is used to heat the oil beyond the pump when the boilers have been banked, or when for any reason the main heater does not function properly. The piping is so arranged that all exhaust steam from the heaters and pump is returned to the boilers.

The oil then passes through a regulator and to the burners, where it is atomized by steam and mixed with air. The burners are placed just below the location of the coal grates, the pipes coming in through the ash doors which are entirely bricked up except for the requisite air slots.

The regulator is actuated by changes in steam pressure and controls the flow of oil to the burners. The supply of air is controlled by the position of the chimney drafts. It is possible to obtain a regulator which will also control the air, but a centrifugal pump load is so steady that practically no change is required in the amount of air needed, once it has been set to meet the atmospheric conditions for the day's run and the complication of such a regulator is not, therefore, justified in this particular installation.

Both boilers are used ordinarily to carry the load, and to prevent its unequal distribution and the overloading of either of the boilers, steam flow meters are being installed to show the respective outputs.

Factory Made Lead Joints for Cast Iron Pipe

A factory made prepared joint for bell and spigot cast iron pipe developed by the research department of the American Cast Iron Pipe is described by Mr. Harry Y. Carson, research engineer of the company, in the July Journal of the American Water Works Association. The joints are made at the foundry and shipped to the job as an integral part of the pipe. The following account of how they are made is abstracted from Mr. Carson's article.

The finished pipe come down the pipe runs. Six pipe at a time are rolled onto a tilting platform and thus are swung into a vertical position with the bell end up. When these pipe stand on end the bells are about 2½ ft. above an overhead platform. Here stand two expert joint makers with the necessary equipment, whose first move is to insert a short mandrel into each of the six vertical bells.

The bell on which this joint is furnished is the ordinary socket as to depth, diameter and other essential dimensions. The slight difference is that the bottom or shoulder of the bell is beveled off on a 30-degree angle as shown in Fig. 1, instead of being square. The lead groove, also, has been made with a sharper shoulder so that the calking is much more positive. A band of iron wedges held together by a strip of lead is first inserted around the mandrel. Two layers of square hemp, especially braided for this purpose, are next inserted and calked on top of the wedges. Then hot lead is poured into the joint and the mandrel extracted, leaving all the joint materials in place.

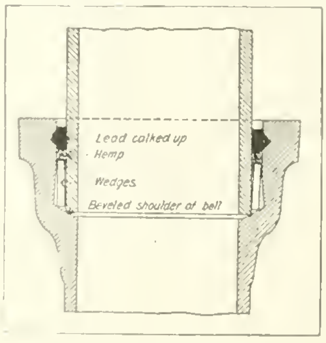


Fig. 1—Cross Section of Partly Completed Joint.

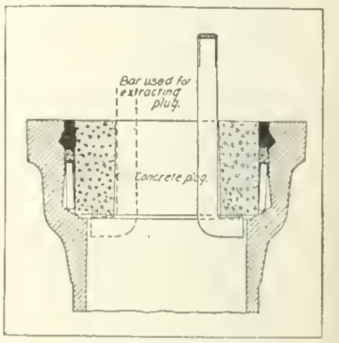


Fig. 2—Method of Removing Concrete Plug.

A concrete plug, shown in Fig. 2, is inserted to protect the joint materials in shipment, and the pipe and joint are ready for the trench. This concrete plug is so designed that it may easily be broken out or jerked out of the bell by means of any convenient bent rod or the bent end of a pinch bar or crow bar on the job. One can thus actually look into the bell and see the condition of the joint materials before they are calked. This, of course cannot be done with the ordinary joint, and is very important.

Knowing the joint is right so far, the trench crew now inserts the spigot of the next pipe, which is so marked as to show when it is fully seated in the bell. The spigott is inserted easily because the mandrel over which the joint was made at the foundry is slightly larger in diameter than the spigot end of the pipe. All pipe with this joint are made without a bead on the spigot end. After inserting the joint "home" in the bell, the calker now simply takes his usual tools and calks the joints in the same way as he would the ordinary joint. With this joint, however, the lead is driven farther back and the force of the hammer blows penetrate to the hemp, which is thoroughly calked as well as the lead. Thus a better and tighter calking is possible.

The joint is designed to fulfill certain definite purpose after it is made. The inside shoulder of the bell, which has been referred to, Fig. 2, engages the iron wedges so that with the slightest deflection of a joint, these wedges are forced along the inclined shoulder and at the same time backward against the hemp and lead. Thus further compression, exerted internally, automatically tightens the joint as deflection takes place.

Influence of Mathematical Speculations on the Progress of Chemistry

A suggestive lecture by Prof. Henri Le Chatelier on the great importance of applying higher mathematics to the study and interpretation of chemical reactions and to the furtherance of chemical research work is published in the May 1920 issue of Chimie et Industrie. The following abstract of the lecture is given in Chemical and Metallurgical Engineering.

Prof. Le Chatelier dwells strongly on the need of a higher general scientific education for the chemist and cites cases where work on chemistry of the greatest industrial importance was brought to successful results not by men who had received only a purely chemical education but by men who had received a solid theoretical education in one of the many engineering schools. This is illustrated by the work of men like Osmond, Deshayes, Charpy, Guillet, Bied and Taffanel, all graduates from the Paris schools of Polytechnique, Centrale or Mines, where they could not have received sufficient experimental training but where they acquired a solid scientific education which soon enabled them to become famous in the chemical research field. If engineers could become such successful chemists, how much greater expectations might be surmised were the chemists to possess also the fundamentals of higher mathematics.

He proposes the formation of special schools of chemistry on lines similar to those of the Paris special school of electricity where only bearers of diplomas from well-recognized educational institutions shall be enrolled. Thus only will it be possible to train a growing number of men theoretically and practically well prepared to direct the chemical industries.

He suggests a program for the organization of the staff of chemical plants. This program calls for a director who shall have the above outlined theoretical and practical education and whose duties shall be to submit to the chief of the laboratory chemical problems and act in a consulting capacity for the solution of such problems. The chief of the laboratory shall outline and direct the laboratory work, devise the appropriate experimental methods, apportion the work among his assistants, control the exactitude of the experimental results, and interpret these results. At present there are no special schools from which men prepared for such work might be recruited. The laboratory assistants shall be experimenters in physics or chemistry, specialists in their line of work. They could be recruited in a satisfactory manner from the now existing schools of chemistry. The help for doing the more or less routine work could be recruited from those with some easily acquired experience in the required line of work.

Prof. Le Chatelier considers the problem of training men for the task of chief of a laboratory of prime importance and dwells especially on their need for quite a thorough knowledge of special mathematics. He illustrates with facts the application of the notion of continuity to the interpretation of the theory of solubility, the utilization of geometric representations especially for the outline of programs of experimental work, the generalization in solving chemical problems by the use of logarithms and a better co-ordination of experimental results and minimizing the experimental errors by applying the fundamentals of the calculus of probabilities.

It is especially in the practical application of chemical mechanics that mathematical knowledge is of great importance. All the laws of chemical mechanics are exclusively of mathematical origin. The number of these laws is small, but their rigorous exactitude makes them particularly useful. He passes them in review and illustrates their importance by enumerating some of their applications. Thus:

The law of factors of equilibrium has served to explain the function of catalyzers in chemistry as being similar to that of lubricating oils in mechanical apparatus.

The law that two systems in equilibrium with a third are in equilibrium with each other and reciprocally has been successfully applied by van't Hoff to the study of the vapor tension of efflorescent salts.

The law of the stability of equilibrium has been used in solving the problems of a better utilization of the sensible heat of gases and is applied to the now rapidly growing industry of synthetic ammonia.

The law of phases has enabled van't Hoff, Bakkhuis Roozeboom and their pupils to solve the complicated systems of salt solutions of [illegible] and of the [illegible] water-salt systems. The same law has [illegible] to establish his [illegible]metric method to the solution of [illegible] problems.

The law of [illegible] to the particularly simple case of [illegible] has been generalized by [illegible] to [illegible] phenomena. This law combined with the law of mass action of several [illegible] has been successfully applied to the synthesis of nitric acid by the electric arc.

He concluded with the plea for changing the educational programs of colleges and universities and for the formation of special schools of chemistry for the theoretical and practical training of chief chemists and chiefs of chemical laboratories.

Activities of Division of Engineering of Illinois Department of Public Health

The large amount of work in connection with improvements or enlargements of existing water supply and sewer systems and the installation of new water supply and sewer systems that is now under way or is proposed or should be carried out in Illinois makes it desirable that attention be called to the information and assistance that the Division of Engineering and Sanitation of the Illinois Department of Public Health will furnish to engineers or public officials.

The activities of the Division of Engineering and Sanitation may be enumerated as follows:

(1) Control of installation of water supply and sewer systems including water purification plants and sewage treatment plants. Examination and approval of plans for all such installations.

(2) Studies of stream pollution.

(3) Sanitary surveys.

(4) Supervision over sanitation of common carriers including sources and handling of water supplies.

(5) Sanitary inspections of public school buildings.

(6) Malaria control by mosquito eradication.

(7) Studies of city waste collection and disposal and street cleaning.

(8) Investigations of typhoid fever and other diseases that may be water borne.

(9) Public addresses on sanitary engineering topics.

(10) Informal advice by correspondence on sanitary matters.

Because of the limited staff it has not been possible to carry on some of the activities enumerated as thoroughly as would be desirable, but special attention has been given to water-supply and sewerage work. Examinations have been made of nearly all existing public water supply and sewer systems, including water purification and sewage treatment plants in the state. Preliminary investigations and studies have also been made in many communities where water supply and sewer systems should be installed or improved. Detailed descriptive reports have been prepared of all of these investigations, as well as reports on the other activities of the Division. All of these reports and other information gathered by the Division are available for public use and any engineer contemplating or doing work in connection with which these reports or information would be valuable, can consult them at the offices of the Division at Springfield, Ill. If an engineer has been actually engaged by a community, copies of reports previously prepared by the Division can often be furnished.

In addition to the assistance that engineers may derive from reports and data collected by the Division, additional investigations can be made in co-operation with engineers that have been engaged by communities to make studies or prepare plans and specifications for public improvements. In this way the Division does not attempt to take the place of a consulting engineer, but, on the other hand, always encourages the employment of competent consulting engineers by communities and then endeavors to assist the engineer in so far as its authority and duties will permit. Experience has shown that this service has been very beneficial to engineers and communities, especially in connection with preliminary studies of proposed water supply and sewer systems.

In connection with the activities of the Division relating to control over the installation or improvements of water supply and sewer systems, it is required that plans and specifications for such improvements be submitted and receive written approval. Experience has shown that this activity has been beneficial to engineers because communities, as a rule, are more favorable to the installation of public improvements which they sometimes consider very costly when they are assured that the improvement has been carefully studied and that the plans and specifications have the approval of a state department which is in a position to examine all such improvements in the state and note their character and efficiency. Moreover, when plans have received the approval of the Division and for some reason or other the community loses interest or delays action, the Division can often be helpful in property presenting the project to the community and having definite action taken.

Plans and specifications submitted by engineers for proposed projects are not open to the public. If, however, an engineer has been engaged by a community, then plans of existing works that may have been filed with the Division are available for review by the engineer so engaged.

The Division has adopted the practice of recommending to communities the employment of competent engineers, experienced in water supply and sewerage work whenever such work is contemplated, but does not suggest names of engineers or engineering firms even when so requested by municipal officials. The Division will furnish to engineers on request, information relative to any particular municipality where water supply or sewerage or other sanitary work is needed, but does not furnish a general list of places where such improvements are being considered or should be carried out.

It is believed that since the creation of the Division of Engineering and Sanitation that there has been an improvement in the attitude of public officials toward retaining engineers in connection with proposed work. Every effort is made to have muicipalities engage competent engineers, when a project is first considered, to make studies and prepare preliminary reports with estimates of cost, and make definite recommendations rather than to have the city officials decide, without having sufficient data before them, what they consider should be done and then engage engineers only to design and carry out the work which the city has already decided upon. There have been several instances where communities were going to undertake work without proper engineering assistance and which work would have been of poor quality if the need of proper engineering assistance had not been pointed out by the Division. It is, therefore, felt that the activities of the Division are not only of service and importance to communities but are of marked value to practicing engineers, and it is, therefore, desired that the engineers who are not now making use of the information and assitance of the Division be made aware that such information and assistance are available and at their disposition.

How to Prevent Sweating of Water Pipes.—Sweating of pipes occurs when cold pipes pass through a space filled with air which is warmer than the pipes and which contains moisture. The contact of the warm air with the cold pipe causes the moisture in the air to condense on the surface of the pipe. Hot water pipes never sweat because the surrounding air is cooler than the pipes. According to a statement of Mr. D. A. Hefferman, Superintendent Water Department, Milton, Mass., at the recent New England Water Works Association convention, this sweating may sometimes be overcome by covering the pipe with 5 or 6 windings of paper with an outer winding of cloth which should be given a coat of heavy paint.

Personals

Edmund B. Besselievre has been appointed assistant sanitary engineer of the State Board of Health of Texas.

R. D. Parker has been appointed chief engineer of the gas utilities division of the State Railroad Commission of Texas.

T. C. Mead has been appointed associate professor of agricultural engineering and irrigation at the University of Idaho.

J. M. Begg, of Montreal, Que., formerly assistant city engineer of Edmonton, Alberta, has been appointed city engineer of Brandon, Manitoba.

Albert H. Wehr, president of the Baltimore County Water & Electric Co., Baltimore, Md., has been appointed state purchasing agent for Maryland.

Athol G. Wright, of Ottawa, has been appointed assistant hydraulic engineer for the Interior Department of Canada, with headquarters at Calgary.

W. C. Davisson has resigned as vice president and treasurer of the West Virginia Water & Electric Co., and will engage in business in Charleston, W. Va.

R. E. McDonnell, of Burns & McDonnell Engineering Co., consulting engineers, Kasas City, Mo., was elected president of the Southwest Waterworks Association, at the ninth annual meeting, in New Orleans, Sept. 24th.

Richard H. Scott, J. G. Reutter, Mrs. C. L. Barber, C. E. Bement, Alderman Doughty, O. E. Eckert, city engineer, and H. Lee Bancroft, city forester, have been appointed members of the city planning commission of Lansing, Mich.

Joshua B. F. Breed, former city engineer of Louisville, Ky., and for a number of years chief engineer for the old sewer commission of that city, has been appointed chief engineer for the new sewer commission, the appointment becoming effective Oct. 1.

John L. Rieger, W. C. Schaub, R. D. Mitchell and Paul H. Strau have been appointed members of the city planning commission of Sandusky, O. The president of the commission, director of public service and the city engineer will form other members of the commission, which was authorized by an ordinance passed May 10.

A. A. Long, secretary of the Kansas Bureau of Muncipal Research, and also secretary and treasurer of the League of Kansas Municipalities, with headquarters at the University of Kansas, has resigned his position in order to return to Austin, Tex. John G. Stutz, graduate of the Unversity of Chicago, has been appointed head of the municipal bureau and is now acting as secretary of the league.

Herbert Hoover has been appointed a member of the advisory board for the eastern industrial region superpower survey, being conducted by the U. S. Geological Survey. Mr. Hoover will serve as consulting mining engineer on the board, which is assisting the Government in the development of plans for a vast superpower stretching from Boston to Washington and designed to supply electrical power to railroads, public utilities and private industries throughout that territory.

Obituaries

James H. Sherman, president of the Sherman Engineering Co., and widely known for his work in constructing flour mills in the West, died Oct. 2 at Kansas City, Mo. Mr. Sherman was at one time instructor in the engineering department of Cooper Institute, New York.

Major Murray Warner, U. S. A., engineering corps, stationed at San Francisco, died Oct. 2, after being stricken with a sudden illness while playing golf. Major Warner, an emergency officer, built Camp Dix, N. J., and previous to entering the army had been engaged in large engineering enterprises in China. He was born in Illinois.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Water Screens.—Link Belt Co., 910 South Michigan Ave., Chicago. 24 page catalog covering the traveling water screens of the company.

Hydraulic Ram.—Rife Engine Co., 90 West St., New York. 12 page circular describing installation and application of Rife rams for pumping.

Sewer Screen.—The Dorr Co., 101 Park Ave., New York, 6 page bulletin relating to use of Dorrco mechanical screen for handling sewage and industrial waste waters.

Reinforced Concrete Pipe.—Independent Concrete Pipe Co., 201 North West St., Indianapolis, Ind. 16 page catalog illustrating and describing use of reinforced concrete pipe for sewers, drains and culverts.

Statement of the Ownership, Management, Circulation, Etc., Required by the Act of Congress of August 24, 1912,

of Engineering and Contracting, published weekly at Chicago, Ill., for October 1, 1920.

State of Illinois, County of Cook, ss.—Before me, a notary public in and for the state and county aforesaid, personally appeared Lewis S. Louer, who, having been duly sworn according to law, deposes and says that he is the general manager of Engineering and Contracting and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher—Engineering and Contracting, 608 S. Dearborn St., Chicago.

Editor—H. P. Gillette, 608 S. Dearborn St., Chicago.

Managing Editor—H. P. Gillette, 608 S. Dearborn St., Chicago.

Business Manager—Lewis S. Louer, 608 S. Dearborn St., Chicago.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) H. P. Gillette, 608 S. Dearborn St., Chicago; Lewis S. Louer, 608 S. Dearborn St., Chicago; Richard E. Brown, 103 Columbia Bank Bldg., New York, N. Y.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.)—None.

1. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

(Signed) LEWIS S. LOUER,
Business Manager.

Sworn to and subscribed before me this 1st day of October, 1920.

H. NELSON (formedly H. Danner),
Notary Public.
(Seal.)
(My commission expires Dec. 3, 1923.)

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago

HALBERT P. GILLETTE, [illegible]
New York Office: [illegible]
Cle[illegible]

The four rotated special monthly [illegible] E. & C. [illegible] entirely cover the civil engineering and contracting field at $4 [illegible] a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. [illegible] foreign engineering and construction [illegible] pletely cover the municipal [illegible] issues of each month completely cover [illegible] The *articles* in the 3rd and 4th [illegible] of each month [illegible] cover steam and electric railway location, design and construction. See the [illegible] of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) M[illegible]
St[illegible]

Railways and Excavation—3rd Wednesday
[illegible]

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sani-tation
(c) M[illegible]
System

Buildings and Structures—4th Wednesday
[illegible]

Copyright, 1920, by the Engineering and Contracting Publishing Company
M[illegible]

Extra postage in C[illegible]

Volume LIV. CHICAGO, ILL., OCTOBER 20, 1920 Number 16.

What Is a Broad Education?

It is customary to speak of technical education as being "narrow" or "narrowing," and thus, by inference, [illegible] tory. By contrast a course leading to a degree of bachelor or master of arts has usually been spoken of as "broad." But what is meant by such metaphorical use of the terms "broad" and "narrow"?

Is education "broad" in proportion to the number of subjects that are studied? If so, every form of education is no wider than a plough furrow on the measureless field of knowledge.

Commenting upon this matter, Prof. Edward J. Kurtz of Pennsylvania State College, recently said:

> The idea in presenting courses in [illegible] specialized courses was to overcome [illegible] was thought to be the narrowing influence [illegible] here is due to the supposition that [illegible] obtained by presenting many diversified [illegible] of having a cultural value [illegible] factor with a superficial knowledge [illegible] field has been spread out [illegible] learning in any one line. This [illegible] . . . Culture is not obtained by [illegible] certain courses, it is an inner tribute [illegible] good things, not a cataloging of them. . . . [illegible] by a desire to perfect and to serve.

It will be noted that Prof Kurtz makes the term "[illegible] educated" precisely equal to "cultured," and that [illegible] cultured person is a highly altruistic person. [illegible] the right thus to come to the conclusion that "[illegible] cated" and "highly altruistic" must be used [illegible] although we grant that a broadly educated person [illegible] to be highly altruistic.

To be well educated, it seems to us, the [illegible] trained as to be capable of succeeding in [illegible] and of enjoying some things other than [illegible] breadth of such an education may [illegible] to the plasticity of the mind, or its ability to [illegible] from one field of work to another, and from one [illegible] to another. Under such a definition of broad education, a [illegible] engineer is quite as ready to qualify as [illegible] holder of an A.B. Prof. Kurtz says:

> [illegible]

[illegible] one of the great [illegible] of an engineering course, but we can not agree that [illegible] particular course a student may [illegible]. The [illegible] engineering courses have altogether too [illegible] of one kind of subject. For example, most courses in civil engineering [illegible] too much time to be spent in the study of stresses and strains. Contrasted with such courses the usual course in mining engineering is a broader course even for the man who plans to become a civil engineer. One reason for this is that mining engineers are trained to become managers of mines. They receive a [illegible] training that is usually not to be had in civil engineering courses. Lack of managerial training has undoubtedly kept many a civil engineer from endeavoring to secure executive control of organizations. In short, his lack of mental flexibility has kept him in a narrow rut from which he would have [illegible] had his training been broader.

[illegible] to push ahead of the crowd and assume leadership, because their training has been such as to develop [illegible]. A good training in management [illegible] if there is any latent desire to lead. The [illegible] of successful leaders in the [illegible] world is evidence of the fact that graduates of American mining colleges have been sufficiently broadened by their training to enable them to become successful executives in a surprisingly [illegible]. Herbert Hoover, for example, is not [illegible] but a graduate mining engineer, and the [illegible] is well attested by the successful [illegible] he has taken up [illegible] and by the [illegible] that he has shown for his fellow men.

Increasing the Efficiency of Maintenance of Way Forces

Railway labor, like all other labor, is at the present time receiving more attention and consideration than ever before, and any one having suggestions with regard to increasing its efficiency is sure of a hearing. Wages have increased, and probably will never return to the level of ten years ago, the characteristics of section labor have changed appreciably, and other conditions have undergone vital changes, making the organization and efficient working of maintenance of way forces a problem quite different and much more difficult than formerly.

At the recent convention at St. Louis of the Roadmasters and Maintenance of Way Association, Mr. F. G. Jonah, Chief Engineer of the St. Louis-San Francisco Ry., presented a paper in which the subject above was thoroughly discussed. He describes a system of time keeping recently started on his railroad whereby it is expected that unit costs can be ascertained which have not been gotten heretofore. The system consists in providing the section foreman with a small pocket timebook, which the foreman keeps at all times on the job, and in which he enters the names of men employed; during the day, he notes in his own language what they are doing, and how much they have done. This is transferred at the close of the day's work to the monthly time book for the last half of the month in which the distribution is made.

It was desired to get cost data on the essential work of track maintenance and, after all, this work falls under comparatively few heads. It was deemed advisable to print the heading for the distribution of time and to make it so plain that the foreman would have no difficulty in transferring from his pocket timebook to the distribution sheet correctly. For accounting purposes, it was necessary to group work under various account numbers.

These books go to the Bureau of Accounts, where the pay rolls and distribution are made up and where the statistical data relating to unit costs is compiled.

With regard to some general features of maintenance of way work, Mr. Jonah has the following to say:

A few years ago many roads bought power cars for their section forces, and, on the assumption that a man could cover so much more territory, lengthened the sections and cut out a few foremen, thus apparently trying to figure sufficient saving in foremen to pay for the gasoline cars. This was at a time when men worked ten hours per day. Shortly thereafter the 8-hour day became general, and the long section is a mistake, as too big a percentage of the day's work is taken up in the time of moving to and from work; and, further, increased traffic, increased number and increased weight of trains all demand more intensive work and supervision, and many sections should be shortened, instead of lengthened. The motor car will be found economical, even on short sections. Wherever a power appliance can be used, it should be. Reduce manual labor to a minimum.

With increased wages, a better personnel can be secured. All sections should be allowed to carry a force the year round, say of at least a foreman and four men, expanding to a greater number at times in the summer. Steady employment the year round will hold good men on the sections, and give the road a chance to develop good foremen for section and extra gangs.

Consideration should next be given to proper housing facilities. The time for box car bodies as houses for families is past, and the day of the hobo is past. Clean, efficient labor demands a comfortable, commodious, healthful domicile, and it will pay to establish these. There is no reason why the section foreman should not be one of the substantial dependable citizens of the community in which he lives. His wages now compare favorably with the village school teacher, and even with many preachers, and the railroads will expect men to measure up to a higher standard than has prevailed in the past.

Extra gangs should be housed in clean bunk cars. A bunk car train should carry a car equipped with shower bath. Cars should be screened and the commissary should be clean and a substantial, nourishing meal served.

Many of us can recall the days of the hobo camp, and few can blame the poor devil who put in a month in one from taking the first opportunity he had (at pay day) of going off on a protracted drunk to forget his misery; and he only drifted back to camp because he had nowhere else to go.

Labor can no longer be held under conditions that prevailed in the past, and the road that will get best results is the one that provides best housing conditions and best personnel; and the latter depends largely upon the first.

Next, after good men have been secured, see that they are fully equipped with a complete outfit of tools. That should be your personal business. Men should have all the tools they need to do any kind of work at any time.

Next is material. Money is wasted if extra gangs and section labor are kept waiting for material.

Do not undertake too much work by doubling up section gangs. It destroys the morale of a section foreman to take him off his own territory to help somebody else out, and the practice should be resorted to only in emergencies—wrecks, washouts, etc. Organize extra gangs to do extra work. Suppose you run three or four section gangs together, at the pay a section foreman gets now, you have very expensive overhead, much more than a good extra gang foreman's salary.

Book Reviews

Surveying. By W. Norman Thomas, Assoc. M. Inst. C. E., Lecturer in Civil Engineering at the University of Birmingham. 6x9 in.; 527 pp.; illus. Edward Arnold, London, and Longmans, Green & Co., New York. Price, $10.50 net.

This is a very comprehensive treatise on a standard subject which the author treats with characteristic English thoroughness and detail. An American engineer or student reading this book will find numerous differences in names and terms and also some difference in type of instruments used, but in the main, as is to be expected, the basic principles of surveying are the same. There are numerous references to American practice and instruments. A goodly number of numerical example at the end of each chapter constitute an excellent feature of the book, some of these being taken from public examinations for surveyors.

While this book is not likely to replace any of the standard American texts on surveying, it should be valuable as a reference book for teachers, students and others.

Dredging Engineering. By F. Lester Simon, Assoc. M. Am. Soc. C. E. 1st edition; 6x9 in.; 173 pp.; illus. McGraw-Hill Book Co., New York.

To quote from the author's preface, this book is neither a compendium of statistics of actual performance nor a compilation of dredging cost data, which information, he states, is obtainable elsewhere. His attempt has been to describe the principal types of dredges so as to impart a working knowledge of their construction and operation and then to consider, in concise form, the usual problems confronting the engineer having to do with dredging. Because of the fact that most literature upon the subject, having been presented in the form of papers and articles in technical periodicals, is not only not readily available, but incomplete, it is thought that the need exists for a comprehensive treatise. It is believed that the author has succeeded admirably in his attempt. The book is clearly written and well illustrated.

Foreign Engineering Review Issue of E. & C.

To the Editor: Permit me to compliment you on your "Foreign Engineering Review" issue which you publish regularly and which is, in my opinion, a very valuable contribution to current American engineering literature.

Being absorbed much of his time in present-day problems, the American engineer will, beyond doubt, be broadened and benefited by seeing the world, now and then, through the eyes of the Old World, or the eyes of the engineers of the Old World. You are doing a genuine service to the members of the profession in this country by this publication of the views of such men as the editors of "Engineering" and "The Engineer" and "The Surveyor" of London, and other distinguished engineers of Europe. Study of such views and opinion tends to make our young engineers, and some of our older engineers, too, more careful, judicious, well-balanced and less crude, it may be. We need to learn (they need to learn from us too, those Old World engineers), and there are some problems that are not susceptible of a quick solution but that must be studied for a long time: and on such problems the experience of men who have given a lifetime to study of these complex questions is in the highest degree valuable. As an admirer of the vigorous, progressive editorials of Engineering and Contracting I congratulate you on this feature of your paper and I think Engineering and Contracting is doing much to advance the engineering profession in America and raise it to the rank and standing it should have among men of affairs in this country.

JOHN WILKES,
Civil Engineer.
Nashville, Tenn.

Allowance for Cut Over Fill in Earthwork

To the Editor: In your issue of Engineering and Contracting of Aug. 18, 1920, there appears a letter from Mr. W. B. Walraven on the Allowance for Cut-over Fill in Earthwork. If Mr. Walraven's letter is worth anything to the engineering profession a little analysis and simplification will be in place.

After making a study of the chart that accompanies Mr. Walraven's letter, I find to be practically true the following: From zero up to 40 cu. yd. of cut per station, the shrinkage is 10 per cent plus 30 per cent or a total of 40 per cent. From 40 to 100 cu. yd. per station, the shrinkage lessens 1 per cent for every 6 cu. yd. increase in the number of cubic yards over 40 per station. For instance 46 cu. yd. per station gives a shrinkage of 10 per cent plus 29 per cent, or a total of 39 per cent. Fifty-two cubic yards gives a total of 38 per cent shrinkage, and so on up to 100 cu. yd. which gives 10 per cent plus 20 per cent, or expressed differently, 10 per cent plus 20 cu. yd. per station. The rule of 10 per cent plus 20 cu. yd. holds, for practical purposes, to a cut of 300 cu. yd. per station. Above this there seems to be some slight variance, which, I think can be ignored owing to the fact that shrinkage is a very questionable thing at the best.

The above indicates to me that Mr. Walraven has shown by his chart that what material reaches the fill shrinks 10 per cent; that 30 per cent is lost for all cuts under 50 cu. yd. per station; that from 30 to 20, varying proportionally, is lost for all cuts from 40 to 100 cu. yd. per station; and for all cuts above 100 cu. yd. per station there is a constant loss of 20 cu. yd.

I am convinced by the above, and my own experience, that the proper method to arrive at any reliable results in shrinkage investigation is first to assume that there will be a certain amount of waste dependent upon the size of a cut and the amount of clearing of debris and amount of blasting. It is evident that this waste will be a large per cent in small cuts and at the beginning of excavation, but will become less in percentage up to a certain limit, above which it should almost become a constant quantity for all cuts, for it is evident that there will be little waste after a large cut is fully opened.

The actual shrinkage should be based upon the actual material that reaches the fill. This will be a constant per cent of the cut, dependent upon the kind of material and the method with which it is placed. Mr. Walraven's experience seems to show that this is an average of about 10 per cent. This is a commonly used factor by many engineers.

If investigations are conducted along the suggested lines I believe that useful data can be gathered. This data need not be shown in a graphical way, for what is easier to remember than, 10 per cent shrinkage plus 30 per cent waste from zero up to 40 cu. yd. per station; 10 per cent shrinkage plus from 30 to 20 per cent waste, varying proportionally, from 40 to 100 cu. yd. per station, 10 per cent shrinkage plus 20 cu. yd. waste for all cuts above 100 cu. yd. per station.

F. W. HOWARD,
Resident Engineer, California Highway Commission.
Crescent City, Calif.

Rail Creeping

To the Editor: There is about to be issued by the American Society of Civil Engineers a paper of mine, entitled "The Creeping of Railroad Rails." It consists mainly of a compendium of information received through questionnaire from over 100 of the highest authorities on the subject in North America. I greatly desire to have this paper thoroughly discussed; hence, if any railroad man who wishes to discuss it will write me to that effect, I shall send him an advance copy provided that his letter reaches me before my supply of copies is exhausted.

J. A. L. WADDELL,
Consulting Engineer.
35 Nassau St., New York City.

Special Machines for Electric Railway Trackwork

In the city of Cleveland an unusual number of [illegible] machines are used in connection with track building and rehabilitation, according to the Electric Railway Journal. Many of these originated with Mr. C. H. Clarke, engineer maintenance of way.

The Clark pavement plow is a device which loosens the paving blocks between the rails at the rate of 3 or 4 miles per hour and has been in successful operation for some years. So spectacular is the operation of this machine that the railway company has had a motion picture film prepared to show how it actually performs.

A special concrete mixing machine is used which was designed with three purposes in view: (1) To insure uniformity in size of the batches; (2) to render equal the amounts of work done by all of the men who charge the machine; (3) to minimize the amount of labor required. The machine consists of two bins for the materials, each divided into four pockets, with an elevating and dumping arrangement for the bins and a horizontal belt conveyor for transferring the batch to the mixer. In the loading position the front edge of the bins is within 8 or 10 in. of the ground, so that a very short lift is necessary in filling them.

Another device which promises important savings is a multiple-tup concrete breaker, applying the principle of the "skull cracker" on a larger scale. It will have 5 pointed hammers, three between rails and one outside on each side, with apparatus for raising them slowly and tripping them at the top of their travel, the whole machine meanwhile being moved forward at any pre-determined rate.

A rotatable derrick, mounted on a 7½ ton Mack truck is another labor-saving device. The derrick has a lifting capacity of 6,000 lb. at 12-ft. radius, with corresponding capacities at other radii. The derrick is operated by a Stearns engine.

A Six-Wheel Motor Bus

The following is taken from a description in Electric Traction of what is stated to be the first 6-wheel passenger bus in America.

This motor bus has been built by the Goodyear Tire and Rubber Co. for use around its Akron factories. It resembles a street car in size and shape; it is 31 ft. long and seats 44 passengers and can accommodate a load of about 80 people.

Actual demonstration and close tabulation of results indicate clearly that this 6-wheeler, or tandem-axle construction truck, with four pneumatic-equipped rear wheels, has steadier riding qualities, better traction, is less destructive to roads, decreases tire weight and costs, reduces axle weight, has greater braking capacity, and permits greater operating radius.

At a recent meeting of the Cleveland and Detroit sections of the Society of Automotive Engineers, P. W. Litchfield, factory manager of the company in question, expressed the belief that the heavy tonnage truck of the future would be some form of the multiple wheel vehicle.

A 6-cylinder Wisconsin engine furnishes the power, and with it a speed of 10 to 12 miles per hour is attained. Enter and exit doors are in the middle of the car after the style of the latest street cars.

The new 6-wheel truck is equipped with 40x8 pneumatic tires (each weighing 119 lb.) in the rear instead of the giant 48x12 (weighing about 398 lb. each) used on the 5-ton trucks. This means a reduction of some 279 lb. in weight which the driver on tire changes has to lift, and in addition, the smaller tires cost almost one-third less than the larger ones. The cost of tire investment is further reduced since the 8-in. tire can be used all around on the 6-wheel truck and the extra tire can be used as the front wheel spare. Another objection to the 48x12 tire, which is entirely overcome by the four smaller tires, is the extremely high center of gravity, the truck load being raised too high off the ground.

Hydraulicing Equipment and Operations on Dam Construction, Lockington, O.

Study and observations of the methods used last season in sluicing material for the hydraulic fill embankment of the Lockington Dam of the Miami Conservancy District, led at the beginning of the present season to several modifications which have been of marked value in increasing the efficiency of the operations. The engineering details of these improvements are described in the September issue of The Miami Conservancy Bulletin, from which the matter following is taken.

The present layout at Lockington is shown in plan in Fig. 1. The water consumed in the various operations is obtained from the Miami and Erie Canal, which runs conveniently a few hundred feet east of the east end of the dam. The quantity required is about 20 cu. ft. per second during two 10-hour shifts. As the city of Piqua a few miles below the dam, depends on this canal for its water supply, it was necessary, in order to insure a sufficiency for conservancy needs, to make extensive repairs to the Sidney feeder, which brings water to the canal from the Miami River at Port Jefferson, and also to the State dam at the latter place. These repairs were accepted by the State as payment for the water to be used. In order to make certain that Piqua should never run short of a full supply, the quantity of water available from these improvements was made considerably greater than the conservancy requirements.

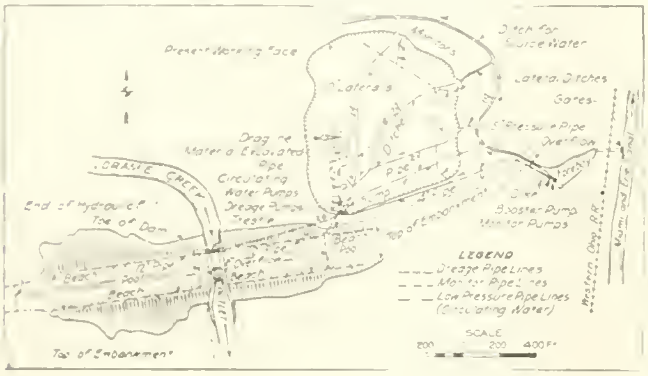


Fig. 1—Borrow Pit and Pumping Layout at Lockington Dam.

Of the 20 second feet taken from the canal, one-half is pumped through the monitors to tear down the pit face. The other half is led over the top of the pit face, wherever the monitor is working, to increase the flow in the sluice ditches. The total flow is picked up by the dredge pumps at the sump, and sent to the core pool on the top of the dam embankment, whence it overflows through vertical shafts in the back of the outlet walls of the dam structure, into the new channel of Loramie Creek, now flowing between these walls. Two subsidiary circulating systems take water from the dredge pump sump, and return it again after using it for sluicing operations in the borrow pit. The entire water system is thus comprised in four parts.

To [illegible] the source of supply, the water is led from the canal, through a pipe culvert controlled by gates, to a small natural reservoir, or forebay, just south of the east end of the dam. The main ditch of the gravity supply takes from this forebay through gates, and is led along the valley slope in a course roughly parallel to the upper edge of the borrow pit and connecting with it by laterals which enable water to be dumped over the bank wherever a monitor may be working. This main ditch has a capacity of about 25 cu. ft. per second, made necessary by the fact that besides the flow from the reservoir, it must also carry the discharge from one of the circulating pumps.

The monitor pump house is located at the west end of the forebay and is equipped with three Allis Chalmers centrifugal pumps, direct connected to 3-phase, 60-cycle induction motors taking current from the Dayton Power & Light Co.'s 30,000-volt transmission line which was extended from Piqua for conservancy use. All pumps on the work are driven by induction motors from this line.

Two of the monitor pumps are 8-in. centrifugal pumps, driven by 100 HP motors and so arranged that they can be connected either in series or in parallel. Each has a capacity of 2,500 gal. per minute against 125 ft. head. The third monitor pump is "a booster," a 14-in. pump with a capacity of 5,000 gal. per minute against 115-ft. head, or of 2,500 gal. per minute against a 230-ft. head. With the two 8-in. pumps working in parallel a pressure of from 40 to 70 lb. per square inch is obtained at the monitor, depending on whether a 5-in. or a 4-in. nozzle is sused. The 5-in. nozzle is used to excavate the pit face where the material (a loamy gravel) is softest. On such material the large jet at low pressure is much more efficient than the same amount of water at higher pressure. For hard clay a 2½-in. jet is used at 175 lb. pressure. To obtain this all three pumps are connected in series. For intermediate materials a 3¾-in. jet is used at about 120 lb. pressure. This is obtained by connecting the two smaller pumps in parallel, and the larger pump in series with the combination. This adaptation of different pressures and nozzles for different refractoriness of the pit materials has proved very advantageous.

The main monitor pipe line runs from these pumps into the pit and along the pit floor roughly parallel with the pit face. It is of 15-in. spiral rivetted steel pipe, 12 and 14 gage. Lateral branches, leading from this main to the monitors, are of 10-in. flanged wrought iron pipe in about 20-ft. lengths.* Since two or three monitor settings are often used in a single day, requiring an almost continual shifting or extending of these branches, gate valves are placed at strategic points to enable these shifts to be made at any time. The total length of the monitor supply line varies from about 800 to about 2,000 ft.

The booster pump on the monitor line, described above, was set at work early in June of the present year, as one of the improvements which last season's experience suggested. A second improvement was in taking a large flow of idle ground water, which ran out of the gravel in the west part of the borrow pit into the dredge pump sump, and setting it at work bringing down material. This ground water diluted the loaded flow from the sluice ditches by about 6 second feet, requiring thus nearly two-thirds of the capacity of one dredge pump just to get rid of it. The idea suggested itself to set up a third pump in the dredge pump house, which should take this idle ground water, and pump it into the gravity ditch above the borrow pit face, thus compelling it, as it came back down the sluice ditch, to bring down a load of material to the sump, and save the dilution and the waste in pumping. This idea was carried out, the added pump being run at a capacity of about 9 second feet, this quantity thus circulating continually, being pumped "empty" from the sump to the gravity ditch, and returning loaded, like a conveyor belt or a train of dump cars. In order that this water might be as free from suspended material as possible, the suction of the circulation pump was led to an auxiliary sump, located near the main sump in a location to intercept most of the ground water flow out of the gravel belt, and connecting with the upper level of the main sump by a pipe culvert, the object of the latter being to steady the sump water level. This circulating water evidently makes no difference with the quantity of water in the sump, since whatever is taken out by the pump is immediately returned by the sluice ditch. Neither does it make any difference in the quantity passing through the dredge pumps. Its operation is simplly to compel all the water passing through those pumps to take a load of material with it.

The flattening of the borrow pit slopes, due to the increase in the sluice ditch flow, has averaged about 1½ per cent, and has increased the quantity of available material in the borrow pit, over the present area, between 200,000 and 300,000 cu. yd. Besides doing this service, the increased flow in the sluice ditches also decreases the labor necessary to keep these ditches clear.

A drag-line excavator digs in the gravel bank in the west part of the pit, below the regular pit floor grade, and throws up a bank of loose sand and gravel to a higher level, to be carried to the dredge pump sump by sluice water. This dragline is a Class B Lidgerwood machine with a 75-ft. boom and a 1½-yd. bucket. The sluice water is supplied by a second circulating system, like the one already described, the quantity being about 8 second feet. It is drawn from the same auxiliary sump that is used for the first system, by a centrifugal pump working at 13 lb pressure, and is driven through a 15-in. pipe to the point of operation. A short length of channel pipe receives the stream of water as it debouches at the base of the bank, and is shifted by hand to accomplish the washing down of the loose material to the best advantage. By this second circulating system an additional 800 cu. yd. of material is fed to the dredge pumps during the day shift, the pump being idle during the night. The dragline excavator, to dig this quantity, has to work during both day and night shifts.

---

*It has been found that longer lengths (of about 30 ft.) of light weight pipe would have been more desirable for these branches on account of the large amount of shifting above noted.

With both dredge pumps running the flow in the sluice ditch is 29 second feet, of which 10 comes from the monitor, 10 from the gravity ditch, and 9 from the circulation system. When the sluice ditch receives also the flow from the second circulation system (that supplied to bring down the loose gravel bank—the flow is increased thereby to 37 second feet, the maximum ditch flow at Lockington. In either case, however, the flow through the dredge pumps is the same—20 second feet, the change being only in the load of material pumped.

It is worth noting also that the water supplied to the gravity ditch by the reservoir, and that supplied to the monitor, is in each case about 10 second feet in amount, and that this is also about the capacity of each dredge pump. This equality in capacity has advantages in operation. Thus if it is necessary to shut down one dredge pump for any reason, it is necessary also to decrease the flow coming down the sluice ditch by the same amount, or the sump will flood. This is conveniently accomplished by shutting the gate leading to the monitor. But this stops the excavation of material, leaving 19 second feet of idle water coming down the sluice ditch. Therefore if the shutdown is prolonged, the gravity supply is decreased, and the monitor again started excavating, the regular operation being then in effect, but with one instead of two dredge pumps working.

The effect of the improvements in the Lockington borrow pit made at the beginning of the present season, may be judged by a comparison of figures taken from the record this year and last. In the best month of operation last year 56,000 cu. yd. of material were deposited in the dam. The last two working months of this year have averaged 78,000 cu. yd.

The location of the dredge pump house and sump at Lockington was determined by several considerations. One was that of safety, the pumps being placed at the lowest elevation which would leave them free from probable damage by floods. To get the pit floor practically on a level with the sump water (as far below this as possible, so as to secure maximum pit depth, the pump suction was lengthened so that the lift varies from 12 to 15 ft., according to conditions.[†] With the elevation of the pit bottom at the sump thus determined, the pump house was located as far down the valley slope as possible, to get it as near as might be to the center of the dam embankment (to save pumping through long pipe lines), while at the same time it was sunk deep enough in the ground to create a sufficiently high pit face for efficient monitor excavation. This was, of course, done at the beginning of last season, before any pumping was done, the excavation for the pumps and sump being done by a derrick rigged as a dragline excavator, the same machine being used later to handle machinery and repair parts in and out of the excavation.

The working force at Lockington is small compared with the material moved. The average is about 19 men on each shift. Four of these are mechanics, engaged in shifting the monitor line, this force being irregular, and the figure given being an average. Four men are engaged in attending the dredge pipe line on the dam, two being at the west pool and two at the east. There are seven men attending the sluice ditches and clearing the grizzly at the dredge pump sump. Besides these, there is a monitor man, a dredge pump runner, a monitor pump runner and a foreman. About 5 teams are also employed during the day shift in removing stone from the borrow pit and in building the beach levees on the dam embankment.

The work at Lockington is in charge of B. M. Jones, Division Engineer; C. H. Shea, Assistant Division Engineer, and G. E. Warburton, Superintendent.

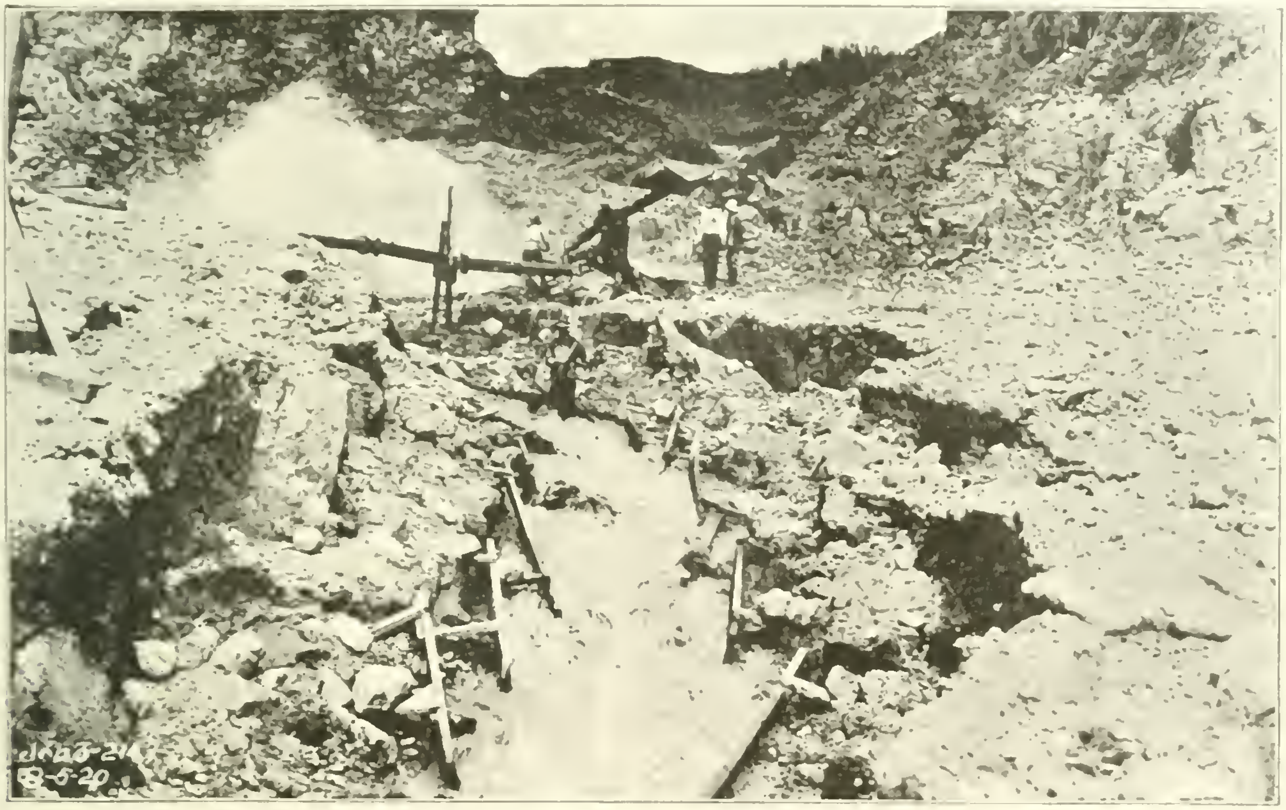


Fig. 2—Photograph Taken Aug. 5, 1920, Showing Monitor Tearing Down Pit Face. Shows Also "Sluice Boards" for Directing Flow in Ditch.

Electrification of Swiss Railways. Switzerland will spend 52,000,000 francs during 1921 for the electrification of railways. By the end of 1922 it is expected that most of the great lines that run through the tunnels, and passes, will be completely electrified.

[†] It was feared that the long pump suction would give trouble by air leakages, necessitating frequent priming, and also by reducing the pump capacity, but by care both of these difficulties have been avoided.

Action of Alkali Soils and Waters on Concrete

For the past 6 or 7 years investigations have been under way in Western Canada on the action of alkali soils and alkali waters on concrete. In a paper presented Aug 16 at the Western Professional meeting of the Engineering Institute of Canada, Mr A. S. Dawson, Chief Engineer, Department of Natural Resources, Canadian Pacific Ry., summarizes these studies and gives the conclusion to date. An abstract of the paper follows:

Preventive Measures.—Any measures that hinder the penetration of the alkali solutions into the interior of the cement will delay the destructive action. For this purpose both soap and aluminum sulphate have been tried, and have been found to afford some protection. The soap, however, in itself had a slightly injurious effect on the tensile strength of the cement

The efficiency of these and of other water-proofings is being further studied, and results may be expected later.

The mixing of cement in weak solutions of sulphuric acid, di sodium phosphate, magnesium fluoride, and oxalic acid has been shown by laboratory tests to increase the alkali-resisting qualities of concrete. The effects of most of the alkalis have also been shown to be less pronounced on neat cement briquettes than on sand cement briquettes, and in fact somewhat proportional to the amount of sand used.

Conditions Found in Practice.—In practice, the worst conditions are generally found on types of structures whose design has necessitated their being backfilled on one side, and subjected to ground water from the same direction—and at or below the original ground surface. These conditions seem to be aggravated where the structures are subjected to dry and wet surroundings—exposed to sun and shade during the winter months—and where alkali salts are most in evidence, and the ground wet. The facts that the deterioration starts on the surface extending inwards, and that the water being carried by the structures has analytically been shown not to be repsonsible for the trouble, would indicate that the deterioration was primarily caused by the ground water and its effects on the concrete. These effects vary in a degree from the surface spalling off in what results in a pile of loose gravel below—to a condition where the mass becomes of a slimy consistency, like so much lime mortar, and mud. As a rule samples in what might be termed an intermediate stage get harder if permitted to dry out in the air—when they become coated with white powdery salts.

Either the disintegration is due to soluble compounds which are leached out of the concrete, leaving it inert, or it is due to the disruption caused by the crystallization of the salts in the pores, or by chemical action of the substances in solution with the constituents of the concrete

Any conditions which will tend to carry the salts from the soil, to the concrete, will hasten the disintegration action and lessen the per cent of alkali necessary to cause destruction.

Experimental Work by Committee of Calgary Branch of Institute.—In October, 1918, 270 concrete blocks and 180 cylinders were made at Calgary, under close supervision.

These blocks were moulded in wooden gang moulds, 10 in. by 10 in. by 30 in. long, and the cylinders in steel moulds, 8 in. in diameter and 16 in. long. Two hundred and sixteen blocks were made, using Western cement, and 54 from Owen Sound cement. All were carefully marked for identification purposes.

All materials used were analyzed physically and chemically.

The gravel was from what is known locally as the Carseland Pit, a well graded, bank-run material. The water was from a city of Calgary main. Samples of soil and ground water were procured from each hole in which a specimen was placed.

The blocks were made in three series.

(A) Screened, sized and washed. The sand was supposed to grade uniformly from fine to coarse—not to exceed 40 per cent by weight, passing a No 30 screen, and not more than 10 per cent by weight, passing a No. 100 screen; and the voids were not to exceed 35 per cent.

The gravel was supposed to be uniformly graded in sizes from $^1/_4$ in. to 2 in. in diameter, and the voids not to exceed 40 per cent

(B) Bank run material, washed.

Bank run material unwashed.

Each series of blocks were made in two mixes.

First, 1:2.4.

Second, 1:1½:3.

Of each mix, three blocks were plain.

Three were treated with two coats of soap and alum.

Three-quarters of a pound of castile soap, per gallon of water, heated to 180° F.

Two ounces of alum to one gallon of water, heated to 100° F.

One coat of hot alum solution.

One coat of hot soap solution.

One coat of hot alum solution, after 24 hours, all well brushed in.

Three were treated with water gas tar and coal gas tar as follows:

First coat, refined water gas tar of thin consistency.

Second coat, same, and immediately after, the first.

Third coat, refined coal gas tar, applied hot, after coats one and two, were well soaked in.

Fourth coat, same as third, after third coat set.

The blocks were taken from the moulds in 48 hours and cured for 28 days, after which they were placed in the ground 22 in., with 8 in. exposed, at the following points:

1. On top of a high hill in Calgary, where no alkali conditions were likely to exist, and where there would be no ground water in contact with them.
2. Near a sewer, in a low lying plot of ground, in Burnsland, Calgary, generally wet, and where alkali conditions had given evidence of being bad.
3. At Strathmore, in a low lying plot, once a slough, where alkali conditions seemed bad, and where they would probably be wet most of the time.
4. Near Brooks, in a low lying place, where the alkali conditions were apparently very bad, and where they would be wet most of the time from seepage water from an irrigation ditch.

The cylinders which were all made of Western cement, were buried at the foregoing points, and 62 were placed in the Calgary city hall laboratory.

Conclusions to Date.—1st. Laboratory test cylinders are all relatively lower in strength than field tests because of the difficulty of maintaining a uniform degree of moisture.

2nd. The blocks and cylinders located in the Calgary district show no disintegration as yet because of the fact that the ground conditions were relatively much dryer than normal.

3rd. The clocks at Cassils show a much greater disintegration than those at other locations because of the greater concentration of soil solutions. Those at Strathmore show the next greatest degree of disintegration, because of less concentration of soil solutions and possibly dying out at certain seasons.

4th. In a concrete of high density, where absorption of the alkali ground water appears to be mainly at the surface of the concrete, the action appears to be relatively slow and is largely in the nature of surface action, gradually extending to the interior.

In a concrete of low density and relatively high porosity the action is more rapid as it appears to take place simultaneously throughout the structure.

The more porous concrete is subject to the action of other disintegrating forces of a physical nature, such as frost action and the crystallization of salts in the pore space.

A dense concrete mixture, through some property not determined, such as low percentage of pore space or the character of this pore space, results in a greater resistance to the action of the alkali ground waters. Apparently this is true in either mixture 1:1½:3 or 1:2:4. Chemical action takes place over relatively small distances, direct contact of the reacting elements being necessary. The more porous concrete allows this more intimate contact throughout the structure; and consequently more rapid action takes place.

5th. The presence of alkali soil solutions does not retard the setting of the cement.

6th. The action is undoubtedly more rapid in weaker mixtures and mixtures of low density.

7th. No apparent difference in results was found in blocks and cylinders made of Eastern and Western cements.

Continuation of Experiments.—The investigations are being continued in several lines that may give further information.

Blocks after approximately 20 months' curing in the Calgary district on which no alkali action has as yet become apparent, have been transferred to the Cassils location, and action of alkalis will be noted.

New blocks and cylinders are being prepared from gunite, and these after curing will be placed in the Cassils location and action noted.

Some tests are being made on waterproofing compounds at the present time.

The important practical phase of this matter is to have further investigation work carried on by competent chemists and engineers, working in close co-operation with one another, and in the meantime for all those concerned, to make use of the existing data, and take all possible precautions and remedial measures to prevent further deterioration to the existing works. In this connection the following points should be noted.

Desirable Features for Concrete in Alkali Soils.—Efforts should be made to get the densest possible mixture, and in this connection the smallest quantity of water consistent to good work should be used; in other words: a quaking mixture should be made of a workable mix, i. e., to a consistency that will permit of the concrete flowing around the reinforcement with thorough puddling, and not so as to cause the finer particles to be carried to the top in suspension and the heavier ones to settle. About 1 gal. of water to each cubic foot of concrete in place is a fair average for a good mix.

The best possible materials procurable should be used—and the best graded mixtures. All bank run material or river gravel should be screened out and remixed in proper proportions—based on proper tests made as to voids.

It is desirable that all material should be washed, and it is almost essential that the sand should be washed; and in this connection it would be folly to assume that sands can be properly selected and passed on, without proper tests having been made on them.

More care should be exercised in making field joints, using ½ of 1 to 2 grout on the junctions between the old and new work.

Where chutes are used, they should be on easy slopes and kept down to the shortest possible length.

The time of mixing is an important factor, and it is now generally conceded that the best results are obtained from machine mixing for a period of about 1½ to 2 minutes continuous revolving of the mixing drum.

Backfilling with sand and gravel with the coarser material next to walls and plenty of weep holes are all extremely desirable, and particularly on such types of structures as have been previously mentioned, and the more easily subjected to alkali conditions.

Closer supervision of all work done, by men who really know the concrete business is essential.

Proper seasoning and protection from the elements, and not too early removal of the forms. It is important to remember that the methods and operations adopted in mixing concrete, are just as important factors affecting its density, strength and permanence, as are the qualities of the materials used.

The use of gunite and gun driven asphalt at normal temperature or heated are being tried out, and are both likely to prove effective methods—not only of damp-proofing and waterproofing, but of preventing the ill effects of alkali salts on concrete structures.

To Organize Oklahoma State Engineering Council.—The Legislative Committee and Ways and Means Committees of the Oklahoma Society of Engineers, of the three Chapters of the American Association of Engineers, of the Oklahoma Section of the American Society of Civil Engineers and of the A. S. M. E. and A. I. M. E., and including also similar committees from the Oklahoma Chapter of the General Contractors of America, will meet at Tulsa, Okla., Oct. 26 and 27, to organize the Oklahoma State and Engineering Council. A large portion of both days will be devoted to a discussion of proposed legislative enactments covering salaries of engineers in the highway and sanitary state service, reducing the multiplicity of utility reports, amending the special assessments paving law, etc. The main visiting speakers will be M. O. Leighton, Washington, D. C.; F. H. Newell, Phoenix, Ariz., and L. K. Sherman, Chicago, Ill.

Methods of Controlling Quicksand*

By CHARLES R. GOW,
Charles R. Gow Co., General Contractors, Boston, Mass.

An experience covering approximately 30 years during which time the writer has had occasion to contend with quicksand under a great variety of circumstances has resulted in the forming of many convictions both as to its nature and methods of control, which it seems worth while to record for the benefit of those who may encounter future similar problems for the first time.

What Is Quicksand?—Contrary to popular impression "quicksand" strictly speaking is not a material but rather a condition of a material, which under different circumstances may possess no such characteristics. Furthermore, quicksand, as such, rarely occurs in nature but usually is artificially produced by the acts of man.

In seeking a definition of the term "quicksand" one may find a bewildering variety of descriptions by present and past authorities. In one case the grains are said to be in the form of an impalpable powder. In another they are spherical in shape; again, the sand contains some clayey substance while still others maintain that a quicksand is any sand which will flow with water.

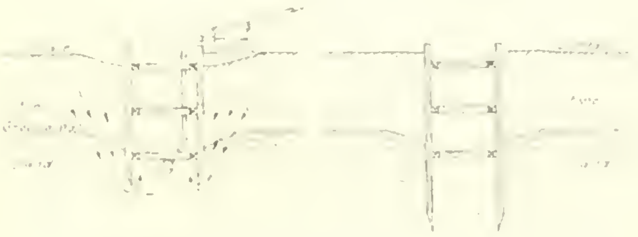


Fig. 1—Left: Inflow of Sand and Water Due to Insufficient Penetration of Sheeting. Right: Greater Depth of Sheeting Preventing Inflow.

Undoubtedly some or all of these characteristics have been noted at times in experiences with quicksand, but none of them is absolutely essential in order to have present the quality of quickness which gives the substance its name.

Any material of a granular nature may become a quicksand if there is an upward movement of ground water through it of sufficient velocity to lift and carry the individual particles. On the other hand, no such material will become "quick" in character unless there is such a flow of water.

One of the best and most inclusive definitions of the term quicksand which the writer has ever seen was given about 20 years ago by Mr. Allen Hazen, in a discussion of the subject before the American Society of Civil Engineers wherein he stated that quicksand is, "A sand containing for the time more water than would normally be contained in its voids, and therefore, with its grains held a little distance apart, so that they flow upon each other readily." Such a definition is applicable to any material, irrespective of its composition which manifests the conditions and behavior usually ascribed to "quicksand."

Excavation in Wet Fine Sand.—A common difficulty encountered in excavations into wet fine sand is indicated in Fig. 1. When the sheeting of the excavation is relatively water-tight, as it must be to prevent the inflow of water and sand through its vertical joints, there may result an accumulation of water pressure immediately behind the sheeting. Unless the sheeting is driven to a substantial distance in advance of the excavation, this pressure may cause a break under the sheeting, allowing the water and sand to flow through the passages thus formed, bringing a considerable quantity of sand from back of the sheeting and leaving a void there which in turn is filled by settlement of the banks above. Thus, it sometimes happens in trenches of this character where suitable precautions are not taken to secure a deep cut-off by driving the sheeting well below the bottom of the excavation, that surface objects find their way by settlement down behind the sheeting until they flow into the trench at the excavation level.

It will usually be found to be economical in cases of this nature to employ matched or tongued and grooved sheeting and to drive the same several feet below the required depth of excavation, in order to avoid disturbance of the adjacent banks and the removal of excessive amounts of material.

---

*Abstract of a paper presented Sept. 7 at the 39th annual convention of the New England Waterworks Association.

Under the same conditions of stratification and water pressure shown in Fig 1, an extremely fine grained sand may assume semi-fluid tendencies due to the upward movement of water in the soil underlying the excavation caused by the water pressure immediately behind the sheeting. In such cases there may be a welling up or lifting of the sand into the trench or pit just as a very viscous liquid may be expected to set. For this reason a trench left over night may be found the next morning to have filled up again to a depth of several feet.

This tendency can be resisted by driving the sheeting deeper and by the free use of gravel or broken stone which forms a surface layer or crust over the sand, permitting the water to escape but preventing the several small boils whereby the sand is carried upward into the trench.

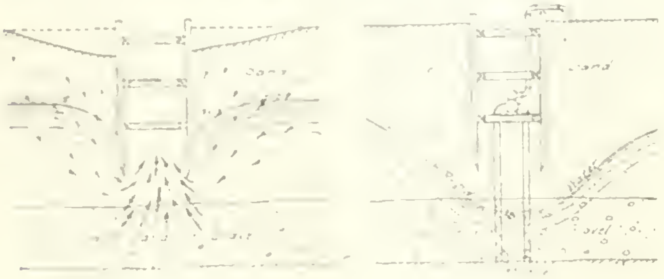


Fig. 2—Left: Upward Flow of Water Causing "Boiling." Right: Bleeding Coarse Stratum to Prevent "Boiling."

How to Handle "Boiling" of Sand and Water in Trench.—A more serious cause of trouble from quicksand and its possible remedy is shown in Fig. 2. In this case an upward flow of water from a coarse stratum below, caused by an unbalanced water head, carries the sand with it into the trench. The sand displaced by this action is replaced by the adjacent sand on either side which flows in laterally to fill the crater thus formed. The result is a demoralizing of the surrounding ground surface and an inflow of sand through the bottom of the excavation which may flow in as fast or faster than it can be removed.

Further driving of the sheeting in such cases is ineffective unless it is carried down to the stratum of coarse material and even then the boiling of sand and water continues although the adjacent ground is protected against undermining.

The most expeditious and satisfactory method for handling such cases is by means of the bleeding process illustrated in the right-hand view of Fig. 2. Perforated pipes or well points of sufficient size and number are driven into the coarse stratum and connected by a manifold as in any driven well installation to a pump of proper size. Provided the capacity of the pump and well system is greater than the amount of inflow at the given point, there will result a a depression of the surrounding ground water level to a depth lower than that of the excavation, thus permitting the latter to be carried on in the dry.

This method is relatively inexpensive compared with the cost of handling a bad quicksand trench and is to be recommended whenever there occurs violent boiling from a lower level.

A somewhat similar but less dependable method of bleeding fine sand where the coarse stratum is missing is shown in Fig. 3. Generally speaking, well points are not effective in fine sand because the amount of water which can be drained by a single point is small, due to the slow percolation through it and the fineness of the gauze screening which prevents the sand from entering the pipe. To meet this condition, however, large pipes of, say, 12 in. in diameter may be driven, into which smaller well pipes are inserted, the annular space between them being filled with coarse sand. If the large pipe is then removed, the coarse sand will collect the water from the fine sand while still holding the latter in place and will readily deliver the accumulated drainage to the well point in the lower end of the well pipe. If a sufficient number of these installations are connected in a given locality the water in the fine sand may be drawn down as in the former case.

Application of Bleeding Method to Driven Well.—An interesting application of this method was used by the writer some years ago to secure driven well supplies for two state institutions. The amounts of water required were not large but there was no coarse stratum available from which to secure the necessary quantity. There were, however, in each instance areas of fine sand deposit containing water. In these cases cylindrical pits 3 ft. in diameter were sunk to depths of approximately 12 to 15 ft. by means of steel cylinders into the wet fine sand. Two-inch perforated well points were inserted in the center of each circular pit and the opening then back-filled with gravel and coarse sand. The steel cylinders were withdrawn and after the several well pipes were connected to a pump a reasonably satisfactory supply of water was obtained. In these cases the locations showing the coarsest of the fine sand deposits were naturally selected.

Deep Excavation Through Fine Wet Sand.—In sinking excavations to great depths through fine wet sand or in those cases where the inflow of water is beyond the capacity of practical pumping operations, resort must be had to the pneumatic or compressed air process. Such a method is illustrated in Fig. 1. The introduction of air into the workings of a shaft or caisson under a pressure equal to or greater than the hydrostatic pressure at the bottom naturally forces the water back into the soil and permits access to the same for the purpose of further excavation. The same fine sand which perhaps has previously boiled violently under the influence of inflowing water so as to be absolutely unstable and incapable of sustaining any weight, is often found under the pneumatic method to require picking for its removal. No better illustration than this could be had of the fact that it is the upward flow of water and not the material itself which results in a "quicksand" condition.

The use of the pneumatic process has been more or less common in the past for the sinking of deep supply wells. Cylinders either of steel or concrete are used as casings and when such casings have penetrated a sufficient depth into porous material, removable plates covering numerous inlet openings around the circumference are detached, permitting an inflow of water from the coarse stratum.

Fine wet sand deposits which offer almost insurmountable difficulties in the case of open excavations may usually be tunneled by the use of compressed air with the utmost ease because in removing the water the material becomes both dense and stable.

Method of Sinking Chimney Foundation to Depth of 40 Ft.—A few years ago the writer had occasion to sink a concrete chimney foundation 20 ft. in diameter to a depth of 40 ft. through a bed of fine wet sand. After excavating to the ground water level, forms were erected for the outer circumference of the foundation and the first 10 ft. in height of the foundation was erected. A working chamber was hollowed out in the under portion and a circular vertical shaft opening 6 ft. in diameter was formed in the center. As soon as the concrete acquired its set, the outer forms were stripped and sinking was commenced by excavating from beneath the cutting edge, more concrete being added at the top as the foundation settled into the excavation thus made. When the sand began to give evidence of boiling or welling up, two steel lock heads with doors in them were built into the central shaft opening 6 ft. apart vertically and the space thus enclosed was used as an air lock. Air pressure was then applied to the working chamber, driving out the water in the sand and leaving an extremely compact material which required vigorous picking for its removal. As fast as the excavation could be carried down below the cutting edge, the air pressure was temporarily lowered and the concrete mass slowly settled to the bottom. In this manner the bottom of the foundation was carried down to a clay hard pan at a depth of 40 ft. below

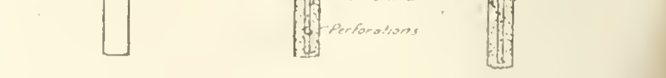


Fig. 3—Method of Bleeding Where Coarse Stratum Is Missing.

the surface. The working chamber and central shaft were then filled with concrete, leaving a cylindrical monolith 20 ft. in diameter upon which the chimney was constructed.

The entire operation required six weeks for completion and cost approximately $12 per cubic yard, including all expense of every description.

Preventing Undermining of Building Foundation.—Several years ago, the writer was called into consultation in connection with an upheaval of fine sand and water in the basement of a mill building which ultimately resulted in serious damage to the structure. A test boring made at the site disclosed the fact that there existed a surface layer of very compact clay hardpan overlying a bed of extremely fine sand about 20 ft. in thickness. Immediately under the fine sand was a substantial layer of coarse gravel containing water under such a head that it rose in the boring pipe to a height 14 ft. above the level of the basement floor, or several feet higher than the natural ground level in the vicinity. A large brick drain below the basement floor permitted the ready escape of the flowing sand onto a nearby beach.

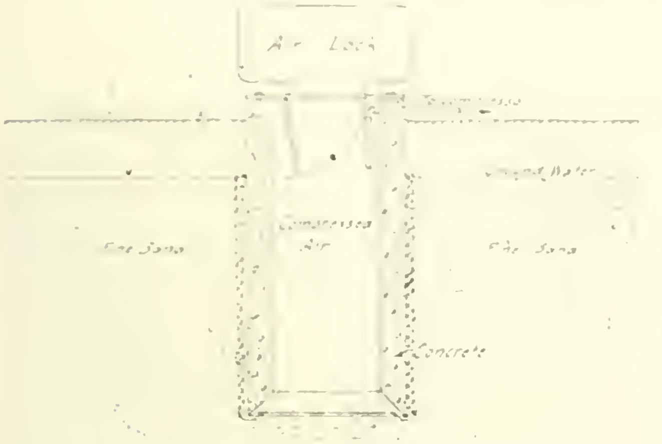


Fig. 4—Compressed Air Process of Sinking Excavations Through Fine Wet Sand.

In order to remedy the difficulty, several 6-in. pipes were driven down to the coarse stratum and their tops cut off just below the basement floor grade. The clear water flows through the open pipes so freely that the ground water head was thereby reduced below that required to force its passage upward through the fine sand, with the result that the flow of sand ceased entirely. Incidentally, a most excellent water supply was secured to the mill for manufacturing purposes but at the expense of rebuilding a considerable portion of the building which was undermined before the remedy was applied.

Foundations on Wet Sand.—It has been the writer's observation that fine wet sand in its normal condition will sustain quite as great a foundation load as will the coarse grained sands. The usual aversion to using wet sand as a bearing material has its chief basis, in the writer's opinion, upon the fact that we usually see such sand in its abnormal and not its normal state.

Some years ago the writer had occasion to construct some pier foundations upon coarse wet sand. The test borings indicated a firm layer of sand, but when the excavation had progressed to this point it was found by the inspector that he could readily force a rod into the soil for a considerable depth. Because of this apparent instability, he ordered that the excavation should be carried deeper until satisfactory material was encountered. The foreman suspended work for the time being and allowed the ground water to rise in the pit to its normal level. Upon attempting again to demonstrate the soft quality of sand by means of the same rod, the inspector was surprised to find that he could make no impression upon the surface of the sand now that there was no longer an upward flow through it.

It is because of the fact that we are obliged ordinarily to produce an unnatural condition in wet sand in order to expose and examine it, that so many people assume this to be its natural state, while the contrary is in reality true.

A perusal of the building regulations of the several large cities will show that fine wet sand and "quicksand" are allowed bearing values of from ½ to 2 tons, while coarse sands are allotted much higher values. It has been the experience of the writer in making tests upon the fine wet sands that they will carry quite as great loads as the coarser sands provided the ground water stands at its normal level.

The chief danger in using such materials for foundation loads lies in the possibility of future excavations being made in the immediate neighborhood which may be carried to a lower depth than that of the foundations referred to, in which case there may be a flow of surrounding soil toward the new opening, thus undermining the foundations. Such damage, however, will occur whatever may be the unit loading upon the soil.

The writer has never hesitated to recommend loadings as high as 4 tons per square foot upon sand which, during the excavation process, permitted the workmen to sink to their knees in it. Nor has there ever been to his knowledge any observable settlement in such cases.

A distinction is often made between fine sand which is confined and that which is unconfined. The surrounding of a foundation site with tight sheeting is useful in preventing subsequent lateral displacement in the event of adjacent excavations being made, but it does not in the writer's opinion increase the bearing value. If the material is a pure sand it will not flow under pressure alone except under excessive loading. In the case of those sands containing a considerable quantity of clay this may not be true. It is not easily possible to determine how much, if any, clay is contained in a fine sand. The individual grains of sand may and usually are so small as to give the mass which they form the general appearance of clay. A microscope may be required in such case to determine accurately whether the particles are of sand or clay. Generally speaking, fine sands containing a considerable quantity of clay will not show the characteristic behavior of quicksand.

Before deciding to utilize fine sand as a foundation for permanent structures, consideration should be given to the future possibility of its becoming saturated under a head which may produce quicksand.

The writer recalls a case in which some mill buildings were built upon fine sand on the high bank of a river. Later a power dam was constructed at a still higher elevation above the mill site and in the course of time the water impounded behind the dam found its way under the dam and into the fine sand which formed the foundation of the mill buildings. This condition was unknown until the pressure broke through to the river, undermining one of the buildings and causing its complete collapse. It should be noted, however, that in this, as in all similar failures, the sand under the foundation flowed to a lower level.

Pile Driving Into Fine Sand.—Those who have had occasion to drive piles into fine sand have usually found a very decided resistance against penetration in such material. This is but another indication of the natural compactness of fine sand in a quiescent state. If a water jet be resorted to, however, and applied to the soil in advance of the pile tip, it will be found that the pile will sink under the weight of the hammer alone. In other words, a quicksand condition is produced in the sand at the pile point and the material no longer offers resistance to the load upon it. It is to be recommended, therefore, that in driving either bearing or sheet piles into fine sand, the water jet should be used as an economic aid to facilitate the work.

In connection with the installation of a number of precast concrete piles some years ago, the writer utilized the jetting process in sinking through a deep bed of fine sand as follows: A long length of ½-in. gas pipe was connected by ordinary garden hose to the city pressure and a jet sounding was made at each pier location at an expense of ½ ct. per lineal foot. Piles were cast of the predetermined length and were jetted down by churning them up and down with an ordinary derrick, a jet pipe having been cast in the center of each pile and connected at the top during driving to a pressure pump. Upon the removal of the jet action the sand repacked itself around the pile in a condition of maximum density.

Precautions for Laying Sewers in Quicksand.—A frequent cause of trouble from quicksand has to do with its escape into sewers, drains or other artificial underground conduits, thus producing voids which must be filled by settlement from above. Any open pipe or conduit laid through wet sand should be constructed with especial care to exclude the surrounding sand. Because of the extreme fineness of many sands this is not easy of accomplishment. When drains are to be laid in such material for the purpose of lowering the ground water level and open joints are left in the pipes to accomplish this result, the joints should not only be wrapped with cloth to exclude the sand, but the entire pipe should be surrounded with soft coal cinders which is one of the most useful agents for admitting water while still excluding the passage of sand.

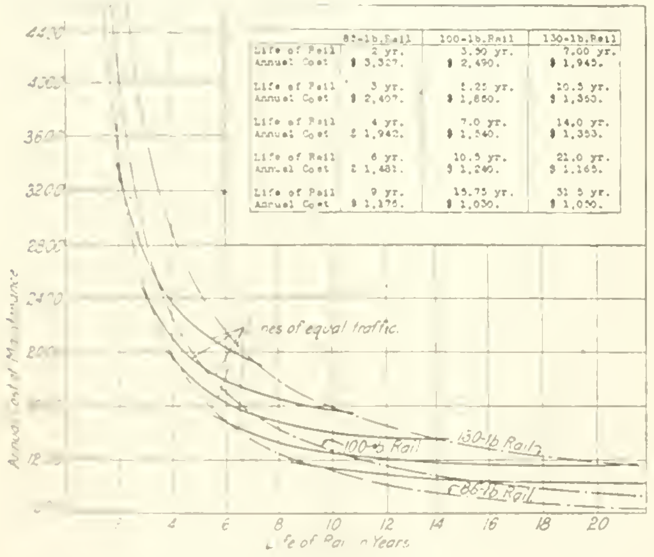
Cinders are also useful during the process of excavating into quicksand for the purpose of maintaining a footing upon which the workmen may stand without sinking into the sand. A frequent liberal sprinkling of this material over the bottom of the trench will be found very effective in preventing miring.

It will also be found in the handling of many quicksands that the ordinary garden fork is more efficient for the purpose than is the type of shovel usually employed. This is due to the fact that fine wet sand has a very pronounced "suction" which causes the blade of the shovel to stick and requires a greatly increased force to remove it.

In conclusion, then, summarizing the foregoing, it may be said that quicksand is only a temporary condition of a soil which ceases to exist after a normal state of ground water has been restored. It is also probably true that many of the troubles encountered from quicksand could often be avoided by the adoption of more scientific methods of handling.

Economic Weights of Rail

At the recent convention of the Roadmasters' and Maintenance of Way Association in St. Louis a committee presented a report on the above subject in which several matters of interest were brought out. The purpose was to develop a method by means of which the economic weight of rail for various classes of traffic may be determined. The actual values used in this discussion are not at all theoretical but are based on performance. However, it must be understood that these values actually represent what must be accepted as a particular problem and that if the method here developed is applied it should be done with values determined to fit the particular case in question. The data used by the committee in making the diagram and in arriving at the conclusions given herewith are as follows:



	85-lb.Rail	100-lb.Rail	130-lb.Rail
Life of Rail	2 yr.	3.50 yr.	7.00 yr.
Annual Cost	$ 3,327.	$ 2,490.	$ 1,945.
Life of Rail	3 yr.	5.25 yr.	10.5 yr.
Annual Cost	$ 2,407.	$ 1,860.	$ 1,360.
Life of Rail	4 yr.	7.0 yr.	14.0 yr.
Annual Cost	$ 1,942.	$ 1,540.	$ 1,353.
Life of Rail	6 yr.	10.5 yr.	21.0 yr.
Annual Cost	$ 1,481.	$ 1,240.	$ 1,165.
Life of Rail	9 yr.	15.75 yr.	31.5 yr.
Annual Cost	$ 1,175.	$ 1,030.	$ 1,030.

Fig. 1—Annual Cost of Maintenance for 85-lb., 100-lb. and 130-lb. Rail.

Cost of new rail per ton	$41.00
Cost to lay new rail, including delivery to work, removing and disposing of old rail, per ton	20.00
Salvage value of old rail, per ton	18.00
Net cost new rail, per ton	43.00
Average labor cost of rail maintenance per mile of track per year—85-lb. new rail—labor at 40 ct. per hour	135.00
Ditto, 100-lb. rail	111.00
Ditto, 130-lb. rail	86.00

The details of arriving at the annual maintenance cost of 130-lb. rail, considering a life of 10 years, are as follows:

Annual interest charge at $13.40 per ton		$ 3.077
Interest at 6 per cent on first cost of track at $43	$2.58	
Taxes at 1 per cent on first cost of track at $43	0.43	3.010
Interest at 6 per cent and taxes at 1 per cent on $18 salvage per ton when removed		1.260
First cost (10-year life) per ton		$ 7.347

Tons of rail per mile of track (130-lb. rail)	204.29
Annual charge per mile of track based on 100-year life	1,501.00
Annual cost (labor 40 ct. per hour) of maintaining 130-lb. rail in 1 mile of track	86.00
Annual cost of maintenance, including interest, taxes, depreciation and labor	1,587.00

The committee concludes that under similar conditions of traffic, the life of 100-lb. rail is 1¾ times that of 85-lb. rail, and that the life of 130-lb. rail is double that of 100-lb. rail. The relative life of over 100,000 tons of 130-lb. rail compared to the life of 100-lb. rail in the same tracks was actually determined, based on four years' experience with the heavy rail, during which time over 4,300 tons of the heavy rail were actually removed from tracks on account of being worn out.

To allow for the comparatively short period of time for which the data concerning heavy sections were taken, the relationship between the average life of heavy section rail and 100-lb. rail was taken to be 2 to 1. The data concerning the relative life of 100-lb. and 85-lb. rail were of a more extended and broader nature, but had not been kept in as detailed a manner.

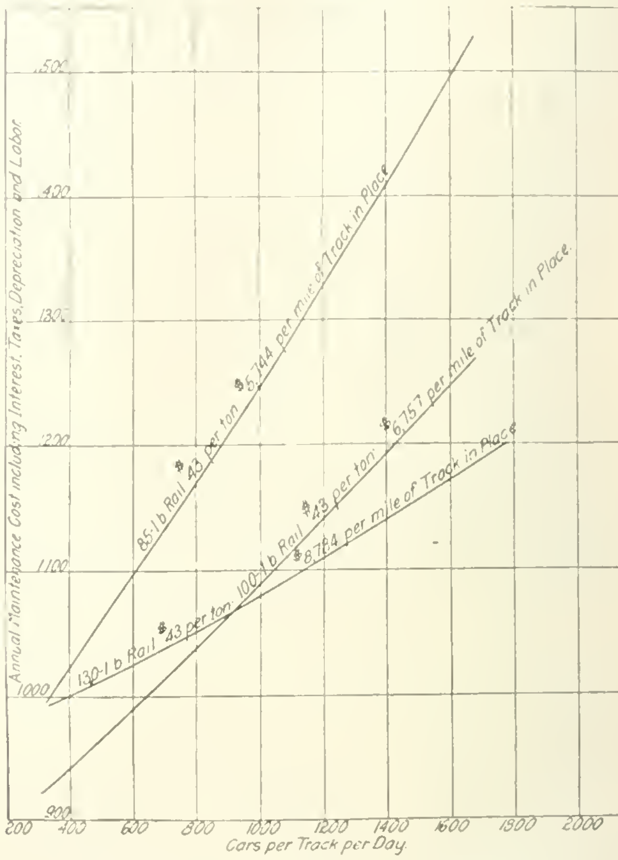


Fig. 2—Effect of Density of Traffic on Annual Maintenance Cost.

Figure 1 also shows the influence of the relative life of 85-lb., 100-lb., and 130-lb. rail under similar conditions of traffic; that is, lines representing the life of various sections of rails under similar conditions of traffic, from which can be determined the difference in the annual cost of maintenance due to different rail sections. For example, suppose 85-lb. rail gave a life of two years—the average maintenance cost is $3,327—then 100-lb. rail should give a life of 3½ years, with an average maintenance cost of $2,490, while 130-lb. rail should give a life of 7 years with an average maintenance cost of but $1,945—clearly a case where heavy section rail could be used economically from a maintenance point of view.

As a measure for the wear of rail under various conditions of traffic, the committee decided on the number of cars per day passing over a stretch of track as the measure of traffic conditions. Such a unit closely reflects the locomotive tons and gross tons; the average weight of cars, the average cars per train and average locomotive miles per train mile ordinarily varying between narrow limits from month to month. Also the average number of cars passing a particular point over a stretch of track during any period can readily be determined at any time without elaborate machinery or organization.

To determine the proper life to assign to 100-lb. rail under various traffic conditions, 14 stretches of track were selected for which information concerning the car movement and rail renewals was available. From this information was determined the average life of 100-lb. rail in each stretch of track. This data varied from 417 cars per track per day to 1,697 cars per track per day.

The curves in Fig. 2 show that the 100-lb. rail is economical for a traffic of not over 900 cars per track per day and that for a greater car movement the 130-lb. rail is economical. As between the 100-lb. rail and 85-lb. rail, the data would indicate that, on railroads using heavy power and having a wide range of physical characteristics, the 85-lb. rail is no longer economical, but that modern railroading demands a 100-lb. rail. When traffic reaches 1,800 cars per day over a double track railroad, the point is reached to consider increasing the weight of section to about 130 lb.

Where Are Our Ties Coming From?

An interesting and authoritative paper with the above title was presented at the September Roadmasters' Convention by Dr. Herman Von Schrenk, Consulting Timber Expert, of St. Louis, Mo. The paper is a presentation of the present situation and of what may reasonably be expected in the future, and is herewith given nearly in full.

Tie Consumption by American Railroads.—The number of ties used by American railroads may at the present time be roughly estimated at approximately 100,000,000 per year. In recent decades the largest number used was in 1907, when 153,699,620 ties were used. During the 3-year test period preceding federal control there was an average annual renewal for federal controlled roads of 91,957,445, and for the ten years preceding federal control an average renewal of 92,293,395. Since the roads under federal control comprise 90 per cent of steam railway mileage in the country, this would indicate an average annual consumption of approximately 104,000,000 ties. The number which will be required from year to year will probably be not less than 100,000,000 and in all probability somewhat in excess of this number, depending upon the amount of new construction undertaken.

Most of the ties used at the present time are wooden ties; substitute ties have made but very little progress. It is estimated that approximately 1,250,000 steel ties have been used, the largest number in the tracks of two railroads. There are probably not more than 50,000 of various cement ties in actual use. These numbers are insignificant when the total number of ties in track may be estimated at approximately 1,200,000,000. The present indications are that the wooden tie will continue to be the dominant tie for some years to come.

The number of ties required per year will be influenced by the life obtained for the individual tie. For the untreated ties heretofore used an average life of about seven years may be assumed. Chemically treated ties have been used in larger and larger numbers; thus, in 1918, 30,609,309 treated ties, in 1919 27,567,927 treated ties were put in track. Treated ties have been in many tracks long enough to materially reduce the annual tie requirements on the lines using these treated ties. If sufficient preservative is available the percentage of treated ties will rapidly increase, thus cutting down new purchases from year to year. Assuming considerable new construction and taking all the foregoing figures into consideration, it is safe to assume that approximately 100,000,000 ties will be required annually for some years to come.

Sources of Tie Supply in United States.—The question which we are interested in today is, where are these ties to come from? There are two possible sources, one from the United States and Canada, and the other, from the tropical countries south of us. A possible supply from Canada can safely be eliminated as a factor because in all probability the Canadian railroads will need the available ties themselves. There will of course be local instances of importations of timber such as Jack pine and cedar, but the actual number of ties will be more or less insignificant.

A tie supply available in the United States is of more immediate interest. There have been marked changes in the availability of ties in various regions. Many roads have for many years obtained their tie supply locally and they are unable to do so any longer, due to the disappearance of the forests in their immediate section and it has been found necessary to import ties from long distances. During the recent government administration, those of you will doubtless remember the shipping of [illegible] from the Pacific Coast to the Atlantic by rail and steamer, and it is interesting to note that many such ties are moving in the same direction at the present time.

Forest Resources of the United States.—The extent of available forested land in its relation to its consumption of lumber, ties, fuel, etc., has just formed the subject of a most exhaustive report by the United States Forest Service in response to the Capper Resolution, [illegible] Senate Resolution No. 311, and all those interested in timber resources, their present condition, the amount of timber utilized annually in various fields, the extent of annual reproduction and statement of the forest resources of the United States which has ever been issued. A few figures from this report may be of interest at the present time. The Forest Service estimates the total stand of available timber in the United States at the present time to be 746 billion cubic feet, of which 187 billion is in the form of saw timber and 246 billion cubic feet is in the form of cord wood. The standing timber is roughly distributed as follows: One half in Washington, Oregon and California, the remainder in the East, North and South; 62 per cent of all standing timber is found west of the Great Plains. Going more into detail, the timber is distributed as follows: New England, 2 per cent; Middle Atlantic region, 2 per cent; Lake region, 5 per cent; central region, 6 per cent, southern Atlantic and eastern Gulf region, 10 per cent; lower Mississippi region, 13 per cent; Rocky Mountain region, 10 per cent and the Pacific Coast region, 52 per cent. Of the total available supply a little over one-fifth is hard woods and the remainder soft wood. The total timber used per year amounts to about 26 billion cubic feet, of which some of the larger items are as follows:

	1,000 cu. ft.
Lumber	8,913,300
Hewn ties	1,050,000
Fencing	1,800,000
Fuel	10,[illegible]50,000
Destruction by fire	1,080,000
Destruction by insects and disease	650,000

At the present rate of consumption it will be noted that there is practically thirty years' supply if regrowth is not considered.

The Forest Service estimates that the annual growth on present forested areas is approximately six billion cubic feet. At the present rate of cutting, the forests in New England, the Middle Atlantic and Central and Gulf states will not last very long. This is speaking in general terms. Quoting from the recent Forest Service report: "Within the next ten years the lumber cut will probably drop to one billion board feet, within twenty years most of the timber areas containing high grade timber will be cut off and the remaining timbers will be either old farm wood lots or on a few remaining large tracts and will be made up of second growth or the trees which were left as worthless at the time of first cutting." Similar statements are made for most of the sections. The southern pine forests are being cut out at a rate which, according to a statement recently made by the Southern Pine Association, indicates that approximately 82 per cent of the saw mills now operating in the South will be cut out in five years or less and over 97 per cent will be cut out in ten years or less with a corresponding reduction in the output of 78 per cent. Attention is called, however, that this does not mean that the total production will be reduced at this rate because there will probably be many small mills in so-called second growth tracts.

The outlook for the 30 years' supply above referred to deals with the timber situation as a whole. In all probability the tie supply will extend for a considerable additional period. Almost any kind of tree is now utilized for tie purposes, particularly since most species have been made more or less suitable for tie purposes by chemical preservation. Then again, the tie supply is not dependent upon the saw mill. The largest tie supply still comes to the railroads in the form of hewn ties, made in many instances in small numbers from farmer's wood lots and so-called cutover lands. As the output of sawed ties is reduced from large mills, the probability is that small mills will appear here and there as they have already done in many of the eastern states, and yield local ties in regions which may have been regarded as wholly exhausted. The A. R. E. A. Tie Committee, for instance, calls attention to what can be done in local production, stating that in the eastern region of the United States Railroad Administration there was an increase of from 3,78[illegible] ties produced in 1918 to 8,485,000 or 150 per cent. on a group of 45 railroads, and this in a country in which it had been assumed there was very little tie timber. Referring to the [illegible] saw mill it will be surprising to most doubtless to learn that as far back as 1909 there were 2,236 saw mills in New York, 2,974 in Pennsylvania, 1,509 in Indiana, 3,48[illegible] in Virginia, most of which cut not to exceed one million board feet per year.

The conclusions to be reached by a careful study of the Forest Service figures referred to indicate that the American railroads need not worry particularly for some years to come. There will doubtless be changes in the sources of supply, changes in the kinds of woods used, changes in the methods to make certain types of wood better fitted for cross tie purposes and probably changes in first cost.

Central and South America as Sources of Tie Supply.—The second source of supply will be from countries in Central America and South America, in other words, possible supplies of tropical hardwoods. From time to time during the last thirty years there have been sporadic tie shipments of one kind and another from tropical countries, but this field of supply has practically not been touched. At the present time numerous offerings are being made of various kinds of tropical woods and a brief review of the tropical situation may not be without interest. Mexico, the nearest country with a relatively large timber supply has a forest area of approximately 20 million acres, most of which belongs to the Mexican government. The forest is of two kinds, the mountain and highland forest, composed largely of pines, and the tropical forest. Some of them of very superior quality. Most of the pine areas, however, are situated on more or less at present inaccessible mountain ranges. The others, or the tropical forest, extends along the edges of the Central Plateau and contains a large number of tropical hard woods. For instance, in the territory tributary to Vera Cruz there are some eighty-five different species of oak. Guatemala, Nicaragua and other Central American republics have large supplies, most of which, however, are located on the western side. On the Gulf of Mexico side there are considerable pine forests, particularly in Nicaragua, Honduras and Guatemala, many of them easily accessible from the coast and producing a species of pine of highly resinous character. Recent samples submitted from British Honduras weighed 58 lb. and more per cubic foot.

The chief tropical resources, however, are in South America. The actual extent of these resources it is almost impossible to state. The Andes Mountains are forested practically for their entire length and very little of the timber in the mountains has been cut, due largely to difficulties of transportation and lack of demand. Brazil has probably the largest area. According to Zon, the Amazon flows for a distance of 1,860 miles through a virgin forest which stretches 1,100 miles from east to west and 750 miles from north to south and occupies an area of 825,000 square miles. This, in the United States would be equal to a section of the country from the Atlantic Coast to Colorado and from Chicago to the Gulf. Several years ago a number of the eastern railroads imported a considerable number of species of wood from the Amazon region, which are now serving in track in New Jersey, New York and Connecticut. The woods are all extremely hard and bear no resemblance whatever to the woods found in the United States. The Guianas are very rich in forest resources and there are numerous rivers which would facilitate bringing out desirable timbers. It is in these countries that the valuable Green Heart and Mora are found. Venezuela and Colombia, although with fewer forests, can also be counted upon for a very large future supply. On the west coast, the mountainous parts of Chile and Peru are extensively forested but there is practically no utilization of their woods at the present time. In fact they import most of their timber from the United States. The West Indies, while heavily forested in some sections, cannot begin to compare as to the quantities available with Central and South America.

While these vast quantities of timber are undoubtedly available in the tropics, attention should be called to the fact that immediate unlimited uses of these resources can hardly be looked for. Tropical timbers grow in dense jungles (excepting the pine forests in Mexico and Central America) and usually a large number of species grow close together. The forest, in other words, is very different from the northern forests where a certain species may predominate on an acre, so that it is comparatively an easy matter in the United States to go into a hard wood forest and cut a certain number of white oak ties per acre, and the same in adjoining acres. In the tropics, however, if one were looking, say, for lignum vitae ties there might be one tree here and then miles away another tree and so on, and then on the acre where the lignum vitae grew there would be fifty or sixty other species. In the event that the tropical woods are used for ties, it would probably be necessary to take a large number of different kinds in order to make possible the cutting of ties at all.

Fitness of Tropical Woods for Tie Purposes.—In this connection it should be pointed out that the fitness of tropical woods for use as ties in the United States is as yet almost wholly unknown. Most species have very hard woods which in their native lands may have given excellent service in the construction of buildings, railroad ties, bridge lumber, etc. When brought to the northern temperate regions however, many of these very excellent woods fail utterly when used in the form of track ties. These hard woods split and check when exposed to the wide extremes of temperature running from zero to 125 or more. In other words, they are unable to withstand the expansion and contraction to which they are naturally subject in most of the regions of the United States. As there is no means of foretelling what any tropical wood is going to do, it is obvious that the purchase of any particular number of any species must be attended with considerable risk. During the last 30 years a large number of species have been imported, but owing to unfavorable records both as to their names, origin and years of service, it is much to be regretted correct data as to their fitness for tie purposes are in most cases wanting. Sufficient is known, however, to indicate that the purchase of tropical woods in the form of ties, irrespective of what country they come from, should be consummated only after the most careful investigation as to their names, and after several years of trial in small quantities of definitely identified species in actual track service in the United States.

This brings us to a brief discussion with reference to names: Large numbers of tropical woods have been offered and are being offered this year. Many of them are offered in the United States bearing a label of some wood species known in the United States. In other words, some hard woods come from Mexico and South America and are called Mexican Red Oak, Mexican White Oak, Mexican Beech, Peruvian Oak, Brazilian Oak, etc. Only last week three samples of wood were submitted from one of the South American countries under various oak names and not one of them was an oak or in the slighest degree even related to the oak family. A prospective purchaser of tropical woods must first of all assure himself that the tropical wood offered has not only the local name by which it is known in the country where it grows, but also the botanical or Latin name, by which alone it will be possible to specifically identify future shipments. It has happened in past years that some tropical woods have been brought to the United States and have given excellent service. When it was attempted in later years to buy some more under the name given for the first shipment it was found impossible to buy a second lot due to the fact that no one in the country addressed had ever heard of such a wood. Too much stress cannot be laid upon the absolute necessity of proper identification. Where tropical tie supplies are under consideration every possible safeguard should be thrown around the proper identification, bontanical and otherwise, of all trees from which the ties are to be made.

It is interesting to note that this year ties are being offered not only from the tropics, but from various parts of southeastern Europe and northern Africa, a condition similar to that which obtained after the close of the Russian-Japanese war.

Protection of Present Forest Reserves.—Reference has already been made in considering the forest resources in the United States to the amount of timber cut and grown. No consideration of a possible tie supply would be complete without very definite and positive reference to the supply which could be obtained if proper forest measures were taken by the government and the people of the United States. Up to the present time our forest resources have practically been slaughtered. It will be noted that the loss annually by fire and disease equals the amount made into hewn ties. There has been so much timber available and the cutting of it has been so much a matter looked forward to only from week to week and month to month that the American public is slow to wake up to the more or less serious situation confronting it. Trees differ from coal and iron in that when once removed from the ground they can be reproduced rapidly. To the majority of people the amount of wood formed in a growing tree appears very insignificant when viewed from year to year, but do not forget that while trees grow slowly they grow constantly as the sun rises and sets and the cumulative effect of this persistent growth when taken over considerable areas is surprisingly large. United States Forester Graves made a statement last year that if the southern pine forest, in all 124,000,000 acres, were fully covered with trees, they would produce at an average of 70 cu. ft. per acre per year, or $27\frac{1}{2}$ billion feet board measure per year. One can realize the enormous amount of regrowth which takes place when one considers that a large portion of the yellow pine ties utilized during the last twenty years has grown since the civil war. Various species of course grow at different rates. In the South, the Loblolly and Shortleaf pines have the highest rate of growth. Of the hard woods, red oak and maple will produce tie trees in a comparatively few years.

Perhaps the best summary of future possibilities is given by Forester Greeley in the Senate Report referred to. "If all of this land had been cut over in the first place with due regard to securing a future stand and had been protected from fires and excessive grazing after cutting, it would now be producing timber at least three times as fast as at present. Judging from the experience of other countries and from results obtained where forests have been carefully treated in our own country, it is believed entirely conservative to assume that the 3,260,000 acres could produce at an average rate of 60 cu. ft. of wood per acre per annum or, in terms of timber, 150 board feet per acre per annum. This would mean a total annual growth on the present area of cut over forest land including that now devastated of $9\frac{1}{2}$ billion cubic feet of wood, including 49 billion board feet of saw timber. At the same rate of production for the remaining 137,000,000 acres of virgin forest in which there is now no net increment, our total commercial forest area is capable of producing annually after the virgin timber has been cut off, at least $27\frac{3}{4}$ billion cubic feet of wood, including 70 billion board feet of saw timber. This exceeds our present rate of use and destruction. With a reasonable per capita consumption it would be able to meet indefinitely the needs of our growing population for wood and various other forest products."

This glowing production could easily be put into actual practice if the American public would only realize how easily this could be done. They would have to adopt measures for fire protection, modify the present tax laws pertaining to forest lands and arrange for proper surface land classification, forest insurance and last but not least, adequate research work to enable those entrusted with forest administration to reach the best results. In this event we would have no tie problem and would be much like the chief engineer of the French-Eastern railroad who maintained that they had no tie problem in France because the beech trees in the Vosges mountains grew fast enough to give them a continuous supply because they creosoted the beech ties and obtained thirty years' service out of each tie.

How We Can Obtain Greater Life Out of Our Ties.—In the first place, every possible effort should be directed toward using only chemically treated ties. With the present high initial cost of the untreated tie a life of 5 to 7 years can hardly be justified. There is absolutely no reason why the life of the average tie could not easily be extended from 12 to 20 years or more. No untreated ties should be used with the possible exception of ties made of the heart woods of cypress, red wood and cedar. Many lines are today treating all ties, including white oak. White oak ties have been regarded as non-treatment ties, but with the poorer quality now going into the manufacture of ties, white oak as well as all other timbers should be treated. It seems rather discouraging to note that in spite of the general appreciation of the value of using treated ties, at present time only approximately one-fourth of the ties used every year are treated. We should take a lesson from our European associates. For instance, in England, Baltic pine ties serve 25 years in the track and then are cut up and made to serve as fence posts and in other places for another 25 years.

A second method by which we can obtain increased service is by being more attentive to the tie from the time it is cut from the tree until it is treated or put into track. A large percentage of ties are lost every year by careless handling. Either they are left in the woods or on the right of way too long and become broken or split and are then considered either entirely worthless or serviceable only in inferior classifications of track. An enormous saving might be realized over the country as a whole if it were more generally realized that all woods cannot be handled in the same manner. White oak will stand considerable abuse, not so red oak, red gum, sap pine. A little planning in the purchase and the inspection of ties will frequently result in not only a tie of superior quality, but in the saving of vast numbers of ties which are now going to waste.

A third method would consist of greater care in the handling and using of ties from the time they are received until they are ready to come out. Included under this heading are some of the following factors.

Work constantly for better drainage of track. A well drained track means that much longer life for the ties. This applies particularly to untreated ties and to ties treated with water soluble salts like zinc chloride.

When using ties treated with water soluble salts, so arrange the shipments and tie insertions that the zinc treated ties may be stacked along the right of way from four to six weeks before insertion. An air dried zinc treated tie will stay in track longer than one put in freshly treated.

Whenever you find a badly checked or split tie, put in an "S" iron or a bolt. This applies to ties before they are treated as well as after they are treated. Remember that every time you throw out a split tie you throw away practically two dollars. In the majority of cases of split ties there is enough sound wood to hold spikes, and a stitch in time saves nine.

When laying ties in track be sure to always lay them with the heart side down. This will materially reduce splitting and checking and add to the length of life.

When handling ties both treated and untreated, do not bruise or abuse them at any time. Holes or bruises inflicted with picks, shovels or track tools cut down the life of the tie to a very measurable degree because it is in such wounds that the decay producing organisms get a start and in cases of treated ties the injury may go beyond the layer of treated wood and thereby cause decay to start. Use tie tongs and other tools which will reduce bruising to the greatest possible extent. This also applies to unnecessary adzing.

Keep all new ties in properly constructed piles. See to it that the lowest tier is at least 6 in. off the ground. Keep the ground around tie piles both in storage yard and along the track, free from weeds. This not only increases the length of life of the ties, but guards against loss by fire. In piling ties keep the upper tier on a slant so as to afford cover against rain and snow.

When spikes become loose, put in treated tie plugs before re-driving. Also, where it is necessary to drive spikes at a new point, plug the old hole with a treated tie plug.

Use tie plates wherever possible and have these with as large a bearing surface as possible. There is nothing which so largely adds to increasing the mechanical service of a tie as a properly designed tie plate. Most of the plates used in the past have been too small. Therefore, use one of sufficient area.

A third factor deals with the matter of keeping proper records. We unfortunately know too little of the actual renewal of ties from various sections and divisions of our railroads. The renewal figures are usually grouped for the whole system. It frequently happens that higher renewals take place on certain divisions than on others. There may be good reasons for such high renewal, and then again, not. Careful records as to details of renewals will abundantly pay for themselves. The data necessary for such records can be obtained by providing either proper dating nails to be driven into ties at the time of laying, or by establishing large numbers of test sections, one or more on each division or geographical territory. Whichever system is determined upon, one or the other should certainly be followed.

The observance of the foregoing suggestions and probably others which will occur to you will not only mean economies to your companies, but will prove a big factor in stabilizing the conditions of the tie industry and in bringing about an immediate reduction in the number of ties actually required each year.

A proper appreciation of the value of the wooden product, whether it be the tie used by the railroad man, the boards used in the building of houses, sidewalks or fences, the poles used in the construction of the telephone and telegraph lines, and the thousand and one articles manufactured from the tree, will altogether make for increasing public respect of this invaluable material and will hasten the day when we will see the realization of the program planned by the Government Forester, when there will be enough boards for all the houses we will require and when the railroad man will have all the ties he wants.

Equation of Track Values for Equalizing Lengths of Sections

For some years past railway officials have been giving thought to the matter of finding a way to accurately measure the different units of work so as to be able to equalize the sections, instead of making the track sections of standard length, as has been so generally the custom.

A committee report to the Roadmasters' and Maintenance of Way Association at St. Louis last month gives the results of two questionnaires sent out last January. The answers represent the opinion of practical track men, engineers and others and as averages are believed to be as near a proper conclusion as it is practicable to arrive at. The committee states that in the main it compares favorably with the findings of several of the large railroad systems which recently made an exhaustive study for their own information.

The questionnaires are shown below:

QUESTIONNAIRE NO. 1.

Subject.	Replies	Average.
How many miles average passing siding equal to one mile of main line?	57	2.75
How many average miles of storage, industrial, or commercial siding equal to one mile main line?	57	3.84
How many average main line turnouts equal to one mile main line?	56	15.3
How many average siding, yard or other inside turnouts equal one mile of main line?	56	16.77
How many average main line railroad crossings equal one mile of main line?	56	10.95
How many average siding railroad crossings equal one mile of main line?	55	19.18
How many heavy traffic, important city street crossings equal one mile of main line?	56	9.20
How many (medium) important city street crossings equal one mile of main line?	57	11.00
How many light traffic street crossings or outlying highway crossings equal one mile main line?	57	20.90
How many average farm crossings or other unimportant crossings equal one mile of main line?	57	46.58
How many average stock chutes and pens equal one mile of main line?	45	17.00
How many average re-icing stations equal one mile of main line?	37	4.15
How many average watering stations equal one mile of main line?	46	5.50
How many average interlocking plants equal one mile of main line?	51	3.40
How many average cattle guards equal one mile of main line?	48	48
How many average feet of track in tunnels equal one mile of main line outside?	38	2.848
How many average coaling stations equal one mile of main line?	47	3.82
How many average fire or cinder cleaning stations equal one mile of main line?	47	2.47
How many average station grounds equal to one mile of main line?	52	5.68
How many average automatic signals and incidental towers equal one mile of main line?	27	20.74
How many miles of average fencing equal one mile of main line?	48	15.07
How many feet of ordinary average ditching will equal one mile of main line?	42	10,160

QUESTIONNAIRE NO. 2.

Subject.	Replies.	Average.
Assuming a double track railroad having an average normal gross tonnage of 10,000 per day or 10 freight trains, 5 in each direction, with an average normal number of 12 passenger trains, using a maximum speed of 60 miles per hour; grade generally level, 1 per cent maximum; line 1 per cent curvature, 6 degrees maximum. What length of section should be established at outlying points if no such conditions prevail as are listed in above questions?	51	3.68
What length of section should be established on a single track railroad, having the same curvature and gradient, with one-half the gross tonnage and one-half the number of passenger trains listed above?	52	6.0
How much should each section be lengthened or shortened for each 1,000 gross tons and ten passenger trains daily that may be added or taken off of such double track section?	35	.911
How much for a single track section for each [illegible] freight or passenger train?	[illegible]	.867
[illegible] should be used in the [illegible] having motor cars as compared with hand cars?	[illegible]	1.17
[illegible] track section?	[illegible]	1.20

Method of Finding Discharge Velocity from Dredging Pipes

A useful method for approximating the velocity of discharge from dredge pipes is described by Mr. Pierce J. McAuliffe in a recent issue of Rock Products. The method was devised by Mr. McAuliffe and has been used by him for the past 12 years. In connection with it he has developed a direct reading gauge somewhat similar to a carpenter's square by the use of which the velocity can be approximated and data on friction, percentage of solids in suspension and quantity of discharge can be compiled. Fig. 1 gives a sketch of this gauge and the method of its application.

The assumptions on which Mr. McAuliffe's method of measuring discharge velocities are based are, first, that the discharge curve will have a definite form for each velocity through the pipe; second, that but two forces act upon each particle in the discharge as it leaves the pipe, these being the pressure developed by the pump (converted into uniform horizontal velocity), and the force of gravity causing each particle to become a freely falling body. Fig. 2 may assist in understanding these assumptions and will also show the method by which the dimensions for the gauge on Fig. 1 were obtained.

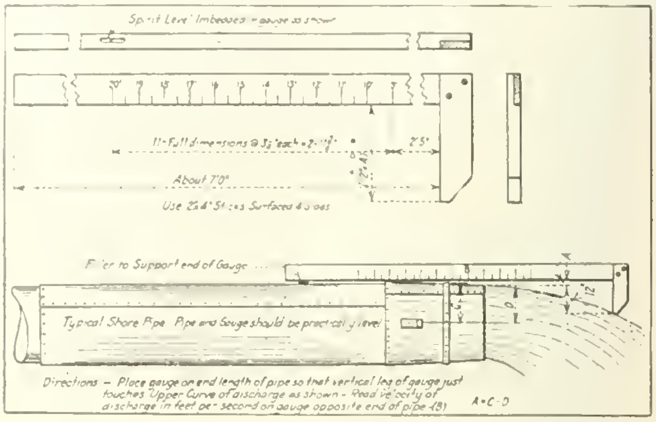

Spirit Level Imbedded in gauge as shown
11-Full dimensions @ 3½" each = 2'-11½"
2'5"
About 7'0"
Use 2"x4" Sticks Surfaced 4 Sides
Filler to Support end of Gauge
Typical Shore Pipe. Pipe and Gauge should be practically level
L
12"
Directions – Place gauge on end length of pipe so that vertical leg of gauge just touches Upper Curve of discharge as shown – Read velocity of discharge in feet per second on gauge opposite end of pipe (B)
A-C-D

Fig. 1.

In applying this method the end length of the discharge pipe should be approximately level. The time that it has taken a particle in the discharge to fall the distance S while traveling along the top curve of the discharge from A to C, can be found by the formulæ $S = \frac{1}{2}gt^2$, or, $t = \sqrt{\frac{2S}{g}}$, in which g is gravity and t will be the time in seconds. Similarly the horizontal distance that the velocity has carried the particle during the time (t) will be L. Dividing L (the horizontal distance), by t (the time of travel), gives the horizontal velocity of the mixture. If the dredge is equipped with a pressure gauge on the discharge line the friction head per 100 ft. of discharge pipe necessary to produce the velocity as found by the above gauge can then be determined.

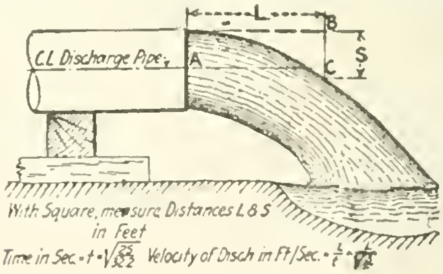

L
B
S
C
CL Discharge Pipe
A
With Square, measure Distances L & S in Feet
Time in Sec. = $t = \sqrt{\frac{2S}{32.2}}$ Velocity of Disch in Ft/Sec. = $\frac{L}{t} = \frac{L}{\sqrt{\frac{2S}{32.2}}}$

Fig. 2.

Salary Schedule for Municipal Engineers.—The A. A. E. schedule of salaries for engineers in municipal service was unanimously adopted Oct. 11 by the American Society for Municipal Improvements at the convention of that body in St. Louis. The schedule was presented in open convention and after full discussion on the floor was adopted. The schedule contains lists of fair salaries for engineers of various grades in cities of different populations.

Methods and Costs of Constructing Public Crossings at Railroad Grade*

It has been the general practice in the past to use plank for the street, highway and farm crossings but the increasing cost and scarcity of lumber and the difficulty in maintaining such crossings under heavy traffic require that we should give some serious consideration to a substitute for lumber.

In some cases it has been the practice to construct crossings of stone screenings or cinders, but this committee does not recommend this type. This type of crossing is difficult to maintain in good condition. The screenings or cinders foul the ballast in the crossing and on both sides of the track for some distance, and this results in rough tracks and damage to the rails.

Concrete slabs are being used at some points as a substitute for plank, and are giving good results. Such crossings installed in 1919 are approximately $1 per square foot, not including the cost of metal flangeway.

The committee last year recommended the use of bituminous and macadamized crossings, and this committee concurs in that recommendation. This type of crossing has been in use since 1912, and has filled every requirement, both from safety and economy standpoint, besides satisfying the critical public. The crossings are easily built and maintained, and are suitable for any class of railroad and in any locality. The committee recommends that as far as possible all rail joints be eliminated in road crossings, that drainage be installed, that all road crossings and highway crossings be made of crushed stone of standard size, mixed either with road oil, bituminous macadam or asphalt, or any other good substance for lumber. The sealing of the crossings with these substitutes will keep out the moisture and frost, and eliminate the heaving of tracks to a great extent, and also the heaving of crossing planks, which is a source of great danger and damage to equipment. On tracks which are located in streets, and the movement of trains is slow, the tracks should be paved with some good material. In the construction of any permanent type of crossing the matter of drainage is of vital importance and the success of the crossing will depend largely on the drainage conditions. Excellent results will be obtained if crossings are constructed according to the following specifications:

Macadamized Crossing with Oil Cover.—Clean out all dirt and ballast down to 2 in. below the bottom of the ties for the full width of the crossing and for a distance of 2 ft. outside of the outside rails.

Replace all damaged rails and ties in the crossing, bond all joints that cannot be eliminated with three copper bonds per joint, put all track through the crossing in first class line and surface, thoroughly tamp them up and install good drainage.

Paint the rails with asphalt applied hot, with a brush or swab, covering the entire surface of the rail below the under side of the head thoroughly, including the under side of the base.

Pack around the rails for a distance of 8 in. on each side with a mixture of crushed stone up to ½ in. in size and hot asphalt, tamping this mixture thoroughly to insure a complete bond with the rail at all points.

Refill the crossing with good clean crushed stone (ballast size), up to the level of the under side of the head of the rail, rolling or tamping it thoroughly.

Cover the entire crossing with fine stone up to the level of the top of rails, sprinkling freely with a good quality of oil while fine stone is scattered. Roll or tamp this covering thoroughly and sprinkle the entire surface with road oil.

The cost of a crossing constructed as above specified with road oil at 1920 prices is:

DOUBLE TRACK

Ballast size stone, 6.46 cu. yd. at 85 ct.	$ 5.40
½-in. size stone, 3.26 cu. yd. at $1.00	3.26
Oil to cover 352 sq. ft., 100 gal. at 29 ct.	29.00
	$37.66

SINGLE TRACK

Ballast size stone, 2.53 cu. yd. at 85 ct.	$ 2.15
½-in. size stone, 1.33 cu. yd. at $1.00	1.33
Oil to cover 144 sq. ft., 50 gal. at 29 ct.	14.50
	$17.98
Planking	$31.00

Macadamized Crossing with Bituminous Treatment.—Clean out all dirt and ballast down to 2 in. below the bottom of the ties for the full width of the crossing and 2 ft. outside of the outside rails.

Replace all damaged rails and ties in the crossing, bond all joints that cannot be eliminated with three copper bonds per joint, put all track through the crossing in first class line and surface, thoroughly tamp them up and install good drainage..

Paint the rails with asphalt applied hot, with a brush or swab, covering the entire surface of the rail below the under side of the head thoroughly, including the under side of base.

Pack around the rails for a distance of 8 in. with a mixture of crushed stone of ½ in. size and hot asphalt, tamping it thoroughly to insure a complete bond with the rail at all points.

Refill the crossing with good clean crushed stone (ballast size) up to the level of the under side of the head of the rail, mixed with a good mixture of good bituminous macadam, rolling and tamping it thoroughly.

Cover the entire crossing with fine stone of ½ in. size, to the top of the rails, thoroughly mixed with good bituminous material and rolled or tamped thoroughly.

The cost of this construction, with bituminous material at 1920 prices, is:

DOUBLE TRACK

Ballast size stone, 6.46 cu. yd. at 85 ct.	$ 5.40
½-in. size stone, 3.26 cu. yd. at $1.00	3.26
Oil to cover 352 sq. ft. at 3 ct.	10.56
	$19.22

SINGLE TRACK

Ballast size stone, 2.53 cu. yd. at 85 ct.	$ 2.15
½-in. size stone, 1.33 cu. yd. at $1.00	1.33
Oil to cover 144 sq. ft. at 3 ct.	4.32
	$ 7.20
Planking	$31.00

Macadam Asphaltic Concrete Crossing.—Clean out the ballast, dirt, etc., for the full width of the roadway, down to 2 in. below the bottom of the ties.

Eliminate all joints, or as many as possible, from the limits of the roadway.

In automatic signal or electric work circuit territory, insulate the rails on all sides, except the head, by the application of asphalt or similar insulating material.

See that all ties through the crossing are good and provided with tie plates under each rail. Tamp tracks thoroughly and see that they are put in first class condition as respects ties, lines and surface.

Fill the spaces between the ties and between the track for the full width of the road between the outside ends of the outside tracks, and the full width of the highway with clean stone ballast thoroughly settled together, this stone of ballast size to come up to the under side of the head of the rail.

Make a concrete mixture of clean small stone or gravel and emulsified asphalt as follows: Select a grade of stone screenings containing particles of stone up to ½ in., but with the fine dust and loam screened out, or a clean fine gravel containing a very small percentage of loam makes a good aggregate. Mix 2 gal. of good No. 1 road oil with 1 gal. of cold water, or larger quantities in proportion. Use 2 gal. of the mixture to 1 cu. ft. of aggregate and mix well until all particles are well coated with this emulsified asphalt, the same as in mixing concrete. Spread the concrete thus made over the surface of the road and roll or tamp thoroughly to the level of the tops of the rails. Better results will be obtained in the way of a smooth surface if traffic can be kept off the new surface about 24 hours after placing. If this is not possible the surface should be watched and ruts smoothed out until it has thoroughly hardened.

When the existing crossing is good except for the top surface, all that is necessary is to scrape off this top surface for about 2 in. below the top of the rail and proceed as above.

Where the track is already ballasted with stone, it will not be necessary to use the quantities of ballast size stone given above, and this will reduce the cost to that extent.

DOUBLE TRACK.

Ballast size stone, 6.46 cu. yd. at 85 ct.	$ 5.40
½-in. size stone, 3.26 cu. yd. at $1.00	3.26
Oil to cover 352 sq. ft., 100 gal. at 29 ct.	29.00
	$37.66

SINGLE TRACK

Ballast size stone, 2.53 cu. yd. at 85 ct.	$ 2.15
½-in. size stone, 1.33 cu. yd. at $1.00	1.33
Oil to cover 144 sq. ft., 50 gal. at 29 ct.	14.50
	$17.98
Planking	$31.00

---

*From a committee report submitted Sept. 21 at the annual convention of the Roadmasters' and Maintenance of Way Association.

Where the tracks are paved with brick at crossing or streets, good clean stone ballast should be provided and this should be covered or roofed with concrete. A sand cushion placed on this and the brick laid and filled with a good binder. This type of construction costs about twice as much as planking, but in many cases will last from 8 to 10 years without repairs.

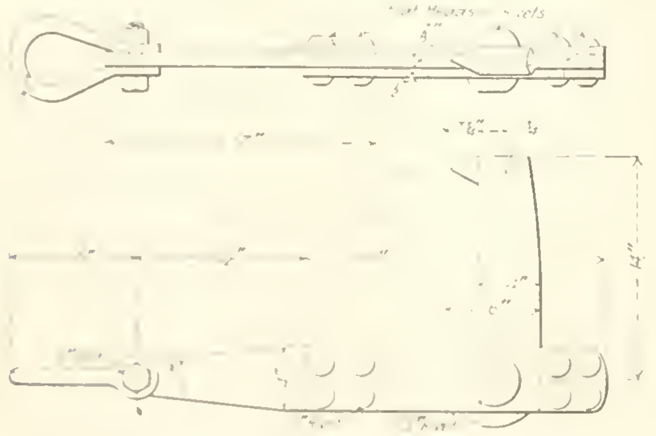
The prices quoted in the tables vary slightly in different localities, but they will be approximate over a large territory, and if local prices are applied to the quantities shown it will give a very good idea of the cost of these types of crossings.

Special Hooks for Handling Rock at Crusher and in Open Pit

In the operation of most rock crushers handling hard ore or rock there is considerable delay each shift due to extra large chunks of rock blocking the mouth of the crusher. Though blasting will usually remove or displace them at the first attempt it should be avoided as much as possible on account of the increased maintenance cost on crusher and building caused by blasting. A special rock hook used at the Cornwall Ore Bank, Cornwall, Pa., in connection with crushing operations, and a special grab used in the open pit mining, are described by Mr. H. H. Hanner in Engineering and Mining Journal, from which the matter following is taken:

At the Cornwall Ore Bank Co., where a hard magnetite ore is mined, a hook has been devised for use with a 5-ton air lift over the crusher mouth and over dump cars. The hook seldom fails to take hold of a rock mass, and retains its grip long enough to at least shift the lump into a new position after each try. On account of the sharp steel point, the hooks cannot slip off the most irregular chunks until the strain is sufficient to cause it to gouge itself out. Quite often, on an extra large slab that is either too heavy to lift or is keyed in with other lumps so solidly that it cannot be shifted by pulling it near the middle with the full five tons, the slab will fail in the center. The steel point is held in place by a cotter pin and the operator keeps a few sharp points on hand.

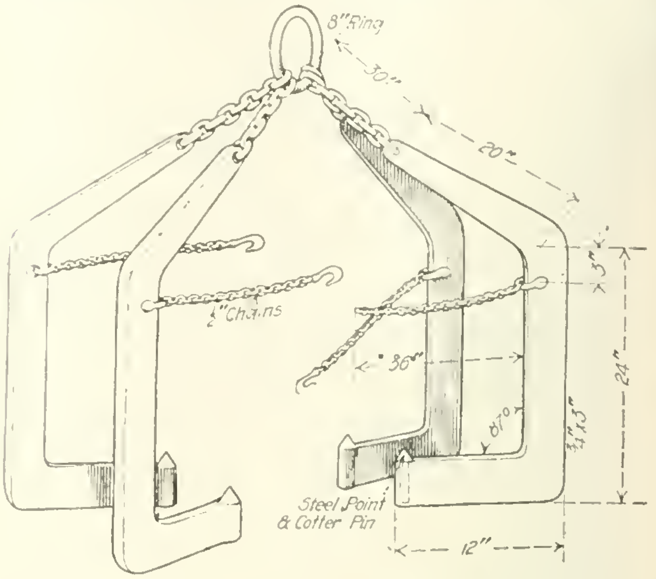
In blasting by drill holes on 70 or 80 ft. banks, the large area that is covered by the scattered rock at the toe of the bank is difficult to clean up by using a derrick and loading buckets by hand. An effective practice is to lay the loading track about 50 to 60 ft. in from the outside chunks and use a ten-ton derrick to clear the roadbed and sweep up the outside chunks. In handling the big chunks of rock with the derrick, heavy tongs were first tried out, but the workmen were reluctant to use them, on account of their weight and because they dropped the chunks about half the time, having only two points of support on the chunk. Lately a four-point grab



Hook Used in Rock Crushing.

that has lifted chunks weighing over eight tons has been tried out and has several good points to recommend it. It is easy to make, convenient for two men to handle, and is quickly attached to irregular chunks lying at random in a pile. Four times out of five it will release itself when the chunk is deposited on the stockpile. The material for the legs is $\frac{3}{4}$ by 3 in., but I would recommend using $\frac{7}{8}$ by 3 in., or 1 by 3 in., when the apparatus is designed to handle chunks weighing more than seven tons, as hooks of the size shown in the figure have in practice required to be straightened out once or twice.

The chunks may be blockholed before or after moving with the derrick, as they are always set down on the stockpile in the same relative position. The jackhammer work can be done before the derrick is advanced far enough to reach the chunk. The foreman marks the chunks he thinks the derrick can handle, and they are not blasted unless the derrick fails to lift them. In this way, most of the large chunks are moved above the loading track without breaking them up and loading the small pieces into buckets by hand. The lower chains, three of which have hooks on the end, are pulled up snug and crossed-tied after the legs are worked under the chunk at points convenient to get at. On round chunks, three legs are usually sufficient to make a lift, but in moving long slabs the four points of support are necessary.



Hook Used in Open Pit Mining for Handling Large Rock Masses.

Concrete Fuel Oil Tanks at Panama Canal Terminals

Three 55,000-bbl. tanks of concrete construction, for the storage of fuel oil have been erected among the steel tanks on the oil farms at the Canal terminals. One was erected at the Atlantic terminal in 1919, and one has been completed at each terminal this year. The following details regarding the tanks are given in the Sept. 22 issue of the Panama Canal Record:

The first concrete tank was 117 ft. in outside diameter, cylindrical in shape, 30 ft. high from floor to top of the wall. The floor was made 6 in. thick, stiffened with 5 rows of beams each way. The beams were 3 ft. wide by 1 ft. deep. The walls were made 6 in. thick on top and 12 in. thick at the bottom, thoroughly reinforced with circumferential steel rods, and enough vertical rods to prevent temperature cracks. The roof of this tank was made of No. 10 gage steel plate, supported on a steel channel and at beam sections, with 25 pipe columns filled with concrete.

A special treatment was applied to the inside surface of the walls to prevent leaking. This treatment is described in Bureau of Yards and Docks specifications for coating interior surfaces of fuel oil reservoirs. A hydrostatic test is made on this type of a tank by filling it with water, which gives higher pressure than crude oil, due to its greater weight.

The two tanks constructed this year differ from the one described above, in that the later tanks have solid concrete roofs supported on concrete beams and columns. Considerable saving in time and money was made by the use of these roofs.

Of the two tanks built this year, with concrete roofs, that at Cristobal cost approximately $17,300, and that at Balboa approximately $53,000, the difference being due to additional cost of excavation on the site at Balboa.

Annual Meeting of National Drainage Congress.—The 10th annual meeting of the National Drainage Congress will be held Nov. 10, 11 and 12 at Atlanta, Ga.

Getting Best Results from Rock Drill Bits

Useful suggestions on how to increase drilling speed and how to reduce steel breakage and tool repairs are given by Mr. Walter E. Carr in a recent issue of Compressed Air Magazine. His article follows:

Few men have become proficient in an art that goes back to ancient times—that of making bits for rock drilling. The knowledge of these few usually extends only to the practice of their immediate vicinity, or, in most cases, mainly to those methods employed within the four walls of the shop where the work is done. Again only those particularly interested in the operation of making bits absorb knowledge through months and years of service with the man who has become expert through hard experimental work and study.

One reason why so few men become expert at this branch of work is that usually the first idea that enters their head is to resharpen as many bits as possible in the shortest span of time, therefore the efficiency of the job is sure to suffer. Doubtless the fine points of the work taught by the expert are forgotten or cast aside as being too "fussy" for general practice. As a result those using these bits have endless trouble.

Nine cases out of ten, at the present day, when trouble is experienced with machine drills, it is steel trouble instead.

The time was, and not so very long ago, that a piece of steel was a piece of steel and a drill bit was a drill bit. So long as it had an edge and carried sufficient gage to allow the following bit to pass to the bottom of the hole, little attention was given the construction of the bit. The idea was to give the bit plenty of spread and clearance. The harder and sharper the rock, of course, the greater the allowance of gage. Frequently $\frac{1}{4}$ in. variation was used between changes of steel.

The origin of the highly modern drill bit was brought about by making a study of bits for hand-drilling contests. The rules governing these contests were that the last bit used in a set of steel was to be no smaller than $\frac{7}{8}$ in. for double hand drilling and generally $\frac{3}{4}$ in. for single hand drilling. Sometimes, however, $\frac{7}{8}$ in. steel was used for single hand drilling also. The steel used in double hand drilling being $\frac{7}{8}$ in. in diameter and for single hand work $\frac{3}{4}$ in., the reader will note that the last bit was the same size as the steel. This rule was carefully adhered to for there were times when some shrewd fellow would swage the last drill down for some distance back of the bit and make his last bit smaller than the steel. This was done to enable him to drive the last drill through the rock a little faster and thereby increase his chances of winning the prize, which would cover him with glory, besides supplying funds for a "big time," where the said funds usually went after the contest was ended.

This swaging, of course, was barred, but the rule of using a bit the same size as the steel always has been, still continues, and doubtless always will be enforced in hand drilling contests.

In a study of this bit-making, the first thing to learn was why the last bit would drive through the rock when only $\frac{7}{8}$ in. in diameter. In other words, why did it cut a margin large enough to permit the drill steel which was $\frac{7}{8}$ in. to follow the bit and also allow for cleaning the hole, which is done by using a small stream of water constantly running into the hole. The blow splashes or drives the cuttings past the steel so effectively that a hole 50 in. deep can be cleaned without an effort on the part of the driller, aside from the blows on the head of the steel, if the bits are made properly.

A theory was advanced and much experimenting was done. Of course, granite was used for all professional drilling and all experimenting was done in the same class of rock.

Hole after hole was drilled, one minute the hammerman striking slow and very hard, the next minute striking very fast and light. Afterward the rock was split to determine the result. The heavy hitting would make a much larger hole than the light hitting, and showed plainly that the vibration cut the margin.

In a set of steel for drilling in a contest of 15 minutes' duration, 15 pieces of steel are used, or one steel for each minute. The contestants generally figure they will drive, or at least should drive 2 in. or more each minute, therefore there is a difference of at least 2 in. between each length of steel. Usually one of the drillers does all of the changing of steel and [illegible] an additional 2 in. of steel to [illegible] into the hole.

When it was fully demonstrated that a [illegible] bit would accommodate a $\frac{7}{8}$-in. piece of steel by drilling one minute in granite, why then would it not be a good idea to make all bits the same size, so that each bit would cut a hole large enough to accommodate a $\frac{7}{8}$-in. piece of steel; then it certainly looked feasible that the whole set of bits would work the same way. If this would be done, great strides would be made in drilling speed for the minimum amount of rock would be cut to drive a hole $\frac{7}{8}$ in. diameter, for the hole would be $\frac{7}{8}$ in. diameter from the collar to the bottom. First only two bits were tried, both being as perfectly formed as possible and both being $\frac{7}{8}$ in. size.

When tested they worked perfectly and the idea was found to be a success. A full set of steel was then made and tried and found to be far superior to a bit with gage. They drilled a hole perfectly round and no matter how poorly they were turned when drilling, the bottom of the hole could be kept practically smooth.

This was another feature of great importance to drillers for, when the drillers make a change or, in other words, when the driller twisting the steel arises to take his turn at the hammer two blows are usually struck by each man, the drill bouncing in the hole. This is called "fostering" by drillers and a bit that will bounce around is more valuable than one that remains in the same spot. If the hole is smooth in the bottom and is kept that way by the bit, the steel will move freely. This shows that such a bit turns easier than a bit with gage, or, at least, with a gage usually used in making drills at that time.

In forming a bit for such drilling it was necessary to make them heavy and strong and of course the degree of hardening was of great importance. It was also necessary to make the bit so it would have the proper clearance, in order that the cuttings would be discharged from the hole. It was also necessary to study the cutting edge pitch to reach a happy medium in a bit that would cut fast and at the same time splash the cuttings from the hole without any effort on the part of the driller, other than hammering. An edge of about 90° pitch seemed to give good results.

It was necessary to flatten and taper the bit slightly on two sides to allow the proper clearance necessary to give the cuttings a good start from the bottom of the hole. The flattening did not extend very far back from the bit and the tapering was not very pronounced, as it was necessary to leave as much metal as possible on the two rounded sides of the bit for the rounded, or corner sides, were those that held the gage and were directly adjacent to the advancing corner of the bit. These rounded corners formed the reaming edges of the bit and served to keep the hole perfectly round and furnished many times as much metal to be worn away as ordinary bits with a sharp corner sticking out which were designed to use gage.

Doubtless the reader could picture the bit in his mind better by taking a perfectly round stick $\frac{7}{8}$ in. in diameter and whittling off a small portion on one end, by tapering the stick slightly or, say, cutting away about 1/16 of it on opposite sides, thereby tapering it abruptly to 90° on the extreme end to form the cutting edge of the bit, the cutting edge being formed by the continuation of the flattened sides being brought together by the 45° bevel on either side. This naturally forms the 90° cutting edge. The rounded or corner sides of the bit the reader will note, is now a perfect circle and instead of only a small point sticking out to hold the gage, the whole rounded sides are corners or reaming edges. These edges were ample to hold the gage of the bit for the hardest kind of service over a period of one minute, therefore it was possible to make all the bits the same size and have them follow perfectly in granite, while the steel used in this work was made from $\frac{7}{8}$-in. octagon bars, after being cut to the proper length for a set of drills each piece was turned in a lathe to $\frac{7}{8}$ in. round, leaving only enough of the octagon for holding and turning.

When forming the bits, a reasonable amount of care was exercised not to heat them too hot, which means burning, and also not to hammer them after they reach a temperature of about 1,400° F., or a cherry red. If hammered too cold, strains are created which only annealing can remove, also the construction of the steel is broken or injured and naturally weakened.

In later years this same idea of reaming [illegible] bit has been adopted by our large manufacturers of [illegible] drills and they are manufacturing equipment [illegible] machines which will, if handled properly, [illegible] ordinary four-point bit into the reaming-edged [illegible] increasing its life many times, besides increasing [illegible] speed greatly by cutting down the size of the [illegible].

This equipment also enables the [illegible] machine operator to gage his bits very accurately [illegible] eliminating much trouble underground from [illegible] and broken bits, to say nothing of time saved in [illegible] steel and of the smaller number of bits to be re-sharpened.

There are large mining companies who have increased their drilling speed 30 per cent and cut down the number of bits to be re-sharpened by half, simply by the strict adherence to the use of modern drill bit and sharpening equipment.

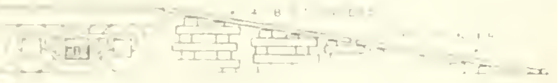
Too many are inclined to treat the idea of increasing their efficiency through the sharpening shop lightly, and give it very little attention, while on the other hand, if shown where 1 per cent can be saved in other departments, expensive changes will be made to meet it.

One of the largest mining companies in the world, which operates numerous mines in the same camp, have one man who is an expert in his line and who does nothing but travel from shop to shop and follow up the idea of making bits as perfectly as possible. They find it pays in big returns.

Increase your drilling speed, reduce steel breakage and save drill repairs by using bits that stand up and drill a round hole when properly made.

Method of Loading Steam Shovel on Flat Car

A small revolving steam shovel mounted on caterpillar traction, was employed by the Fred R. Jones Co., Chicago, in widening cuts, making fills, extending sidings and building new sidings for the Pennsylvania R. R. The shovel was an 18-B Bucyrus, equipped with a 28-ft. boom and a 20-ft. dipper handle. The work extended over about 90 miles of line between Morrisville and Bicknell, Ind., and was divided into 8 separate jobs. An interesting feature of the work was that it was necessary to move on to each one of these 8 different jobs, but in only one instance was it found necessary to knock down the shovel. In making these moves the shovel was run up on to the main line and cribbing built for a runway up to a flat car.



Method of Building Incline to Flat Cars.

The following account of how the shovel was loaded into the flat car is taken from the September Excavating Engineer.

The runway was built in the following manner: Four sets of cribbing were first placed, as shown in the sketch. On this cribbing were laid six 18-ft. stringers, four of these were used at the top of the incline, two on each set of cribbing and two at the lower end of the incline. The purpose of having four at the top was to make a little safer foundation for the caterpillars, inasmuch as two stringers will be under each caterpillar, thus obviating the danger of slipping off the incline. The cribbing was made from railroad ties. The shovel was run down over this cribbing with the boom lowered. When the shovel was lowered, the stringers and the cribbing were picked up and placed on the car with the dipper. The time in loading averaged between one hour and one hour and a half, with about one hour for unloading.

Examination for Government Highway Engineers. The U. S. Civil Service Commission, Washington, D. C., has announced an open competitive examination for highway engineer. Vacancies in the Bureau of Public Roads, Department of Agriculture, for duty in the field, at entrance salaries ranging from $2,100 to $3,000 a year, and vacancies in [illegible] requiring similar qualifications, will be filled from this examination. Applications will be received until Dec. 28.

Utility Regulation and Rate of Return*

By CECIL F. ELMES,

Chicago Manager Sanderson & Porter.

The present unsatisfactory state of the public utility securities market is ample justification for the present paper. The term "public utility" is commonly applied to street and interurban railways, electric, gas and water companies, telephone and telegraph companies and more or less occasionally to such industries as cold storage or warehousing. Steam railroads are usually regarded as in a class by themselves. The reader's indulgence is asked in regard to a general application of the term "public utility" or "utility" herein to include also steam railroads. This is done, without confusion on the writer's part, in the interests of brevity. Statements made will apply equally to railroads and to industries usually included under the designation "public utility."

At the outset it may be stated that there is every reason why utility securities, in the absence of undue influences, should command a wide measure of public favor. They are issued by merchants whose wares are a public necessity, the demand is, in general, less liable to capricious fluctuation than almost any other department of commerce. The typical consumer of gas, for instance, makes little change in the habits of his household, on his own initiative, by reason of "boom" times or panic. He travels daily to business whether business be flourishing or dull.

In the great majority of states, utilities are subject to regulation by Public Service Commissions; the steam railroads, of course, being further subject to the jurisdicton of the Interstate Commerce Commission. It is only fair to say as to these bodies that they command a wide measure of respect alike from the companies they regulate and the body of the public. Their duties are discharged with fairness, faithfulness and a degree of enlightenment as to the economic conditions of the day fully comparable to that displayed by other authoritative bodies.

Commissions openly express an intent not merely to safeguard the interests of the public, but to promote the stability of the utilty concerns which are to give that public a high standard of service. Nevertheless utility securities do not reflect optimism as a result of these assurances. The present paper is an effort to find out why. It is not directed, in the main, to the work of public service commissions, rather it is an effort to go deeper, to analyze the underlying causes of the present state of the industry.

Present Regulation and Isolation of the Utility Business. – The regulation to which utilities are subject at the hands of public service commissions is, in general, in additon to all other regulatory action to which they are already subject. Sometimes, and within limits, municipal regulatory powers are modified by statute or court decrees as a result of the existence of a commission. Otherwise, commission regulation is usually superimposed upon any regulation or control already in existence.

Utility men are today so much in a class by themselves that most of them scarcely realize how different is the authority to which they are subject compared with the control exercised over almost any other form of business. An immense number of the men in the utility business never engage in any other. Their training is exclusively along lines adapted to public utility work; their reading on business and economic subjects is largely confined to features special to the utilities. In no small measure they tend to have their own group of manufacturers specializing in products intended exclusively for some branch or other of the utility industry. The public service commission is their court, distinct from the courts to which all other citizens may have recourse. They have an extensive and varied literature of their own, and it is interesting to note how this literature tends more and more to take present methods of regulation for granted. Commission rule, a comparative mushroom growth of scarce 10 or 15 years, is spoken of as though it had always been. Methods of regulation which have just come into existence are treated as though centuries of precedent stood behind them.

It would be easy to make too much of the mental isolation and segregation of interest among utility men today. Nevertheless the drawing apart of any one class from the balance of the body politic, either as a social, a political or an economic matter, is not to be desired. Our democratic form of civilization has always been inimical and usually fatal to such a process.

---

*Abstract of a paper presented Oct. 11 at the annual meeting of the American Electric Railway Association.

How many utility men, for instance, have any idea how the development and growth of the utilities compares with that of the country as a whole. Are they keeping pace with it or are they falling behind? The chart (Fig. 1) shows something of this in regard to the greatest of our public services, i. e., the railroads. In 1870 the mileage was 1.68 per 1,000 inhabitants. It has grown to about 2.52 miles, an increase of 50 per cent. Take bank deposits as a conveniently accessible figure with which to indicate the general commercial development of the country. In the same period these have increased from $49 to $310 per capita, an increase of 530 per cent.

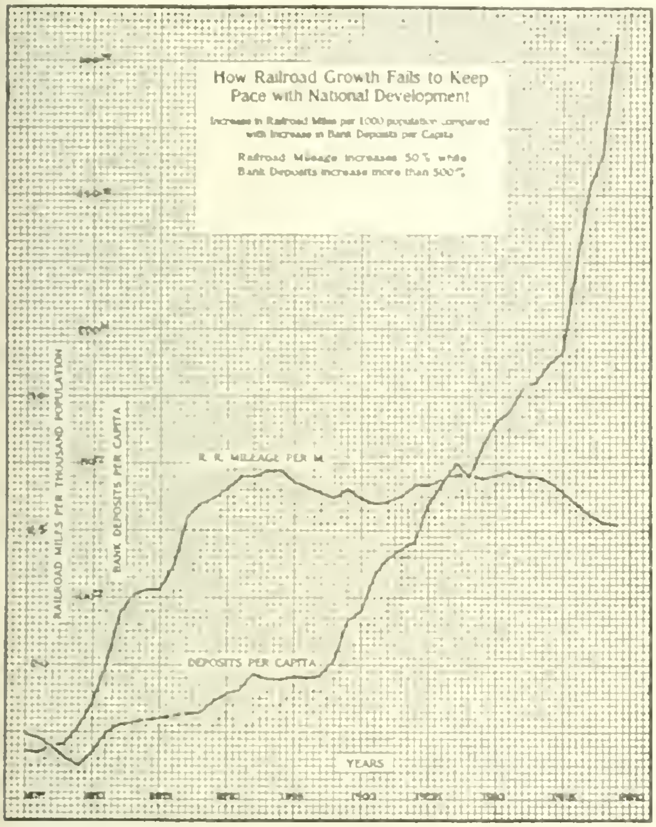


Fig. 1—Chart Showing How Railroad Growth Fails to Keep Pace With National Development.

This paper will have served a useful purpose if it leads some utility men not to assume that whatever is customary today in the public utility business is right, if it leads them to take note of how far they are subjected to treatment, especially economic treatment—different from that accorded to the general body of citizens and to investigate, in a broad spirit, the grounds for such discrimination.

A Dual Standard of Commerce Regulation.—There exists in the United States today a dual standard for the regulation of commerce. On the one hand is a well defined and compact body of precept and practice put into force by public service commissions and applied solely to those few businesses previously mentioned. On the other hand is an almost complete lack of system, little more than a vague general impression that merchants should keep within the bounds of reason, and that all men should unite, if need be, to make them do so. This lack of regulation applies to every other branch of commerce, including businesses so vital to the public welfare that a serious breakdown in them might prove a national tragedy.

In spite of the fact that utility regulation is a growth of only the last 10 or 15 years, public understanding of the whole subject is so restricted, public interest in political economy and jurisprudence so slight, that in broad measure, the public is today unaware that such a dual standard has come into existence. That the public, if fully informed, might regard a dual standard of [illegible] as equivalent to a dual standard of [illegible] to assert. And, upon the single occasion [illegible] the dual standard, that public interest [illegible] became intense during the war period, the dual standard was swept out of sight without ceremony and [illegible] almost overnight.

It cannot be said that public opinion in that very period sanctioned the thought that [illegible] merchants should be regulated and butchers and bakers left to their own devices. In an incredibly short time with rough but effective governmental machinery, all commerce in which public interest was vital, was placed under control. No question was raised, no hairs were split as to whether particular lines of trade might or might not be controlled. There was complete acceptance of the principle that if public interest proved great enough in any industry, it would be subjected to control. No distinction was raised as to whether the commodity was or was not controlled by a monopoly, or whether it could or could not be defined as a public utility. Unlimited technicalities and legal questions might have been raised but no one wanted to raise them. There was abroad in our land that manifestation of public will which is the ultimate law to legislatures and judiciaries alike, which not only guides them but creates them, and which, if the public need be grievious enough, may also remake or destroy them.

How, then, if aroused public opinion showed so different a spirit, has the dual standard of commerce regulation been justified or condoned? How is it even now coming back to full strength as the war-time interest of the public in economic problems wanes? It is defended on three main grounds:

First, that the commodities dealt in by utilities are a public necessity.

Second, that utilities are, in a measure, monopolies, and—inferentially—that other businesses are not.

Third, that utilities are possessed of valuable franchises derived from the public.

Reliance is usually placed not on a single one of these grounds but on all three—and wisely so. Each of them is vulnerable.

If the rule of public necessity is to be our guide why limit our scope to gas, which is but one of many fuels, or street cars, which leave the streets free to all manner of other vehicles, or storage warehouses, which fall in the category of minor industries, while overlooking bread and meat and coal?

If monopolies are the only business to be regulated why select this limited group when so many other unregulated but equally powerful monopolies exist? Has a utility ever been released from commission jurisdiction where, as is often the case, it is not a monopoly?

If the value of franchises be the test, have utilities been excused from regulation where the franchise is not merely valueless but a liability? What of states where the utility law urges or permits utilities to toss their franchises in the waste basket and operate on indeterminate permits? Can the state, in the same breath, base the right to regulate upon the evident value of the franchise and forbid the utility recognition of any value therein in its capital account without being open to a charge of taking property without due process of law?

Investment Issues—A Well-Meant Legislative Bungle.—Out of the great concentration of capital into trusts and other combinations in the '90's and the first years of the present century, there grew a spirit of unrest against indiscriminate increase of capitalization. How far the movement was justified by fact is a subject which space forbids us to consider. Let us assume for the purpose of this article that there were abuses and that it was the part of legislative wisdom to check them. Be this as it may, the fact is that an almost country-wide movement ensued, with legislation in most of the states, in regard to the issuance of capital stock. The intent of practically all such legislation is to compel a dollar of capitalization to represent a dollar of cash investment.

In certain states, such as Delaware, the law is less stringent than in others, and allows the issue of capital stock to correspond to the honest judgment of the directors as to the worth of their property. In many others the law demands in effect that capital stock be issued for cash at par. No doubt the framers of these statutes were animated by the best of intentions and the thing they sought to achieve by legislation was healthy in principle. But what was aimed at was to a large extent not accomplished and, on the other hand, a discrimination which was never intended was brought about.

The laws regulating capital stock issues at first blush apply equally to every corporation. But since there is, in effect, supervision and control of utilities through public service commissions, and little or no control by anybody over other corporations, these statutes, in their working, operate to the peculiar disadvantage of utilities. Commissions have no choice but to enforce the law against a utility company, and insist that capital stock issues shall represent cash investment at par. There is, generally speaking, no similar body to compel equally rigid obedience to law by other corporations.

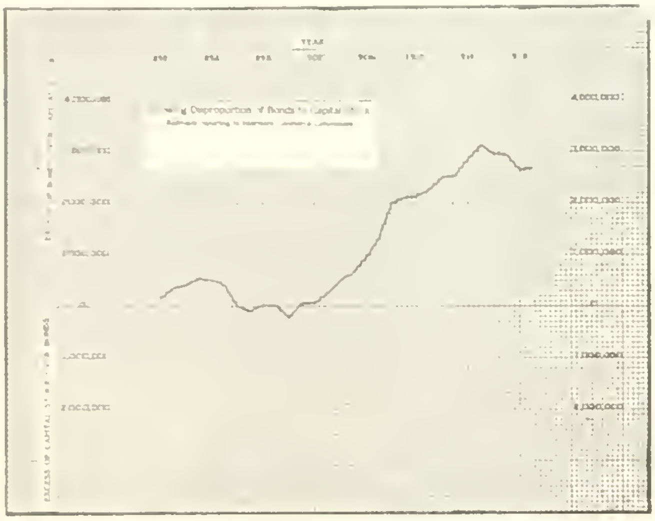


Fig. 2—Growing Disproportion of Bonds of Utility Companies to Capital Stock.

Further, the legislation in question affects only capital stock. It does not prevent the sale of bonds or notes at a discount. The investing public naturally enough will not pay par for offerings of second class where investments of the first class are available for less. Out of this condition has come the present state of affairs where utilities are forced against their will, to secure capital necessary for their growth by the unhealthy device of increasing the ratio of bonds to stock.

The net result of this legislation and its enforcement has been that the only corporations effectively compelled to its obedience—i. e., public utilities—selling their bonds or senior securities at a discount, as they often must, are practically debarred from selling their junior and speculative securities at all since they must sell them at par. The chart (Fig. 2) is an interesting illustration of how the steam railroads of the United States have swung over in less than 20 years from a condition where outstanding stocks were in excess of bonds to one where the bonds exceed outstanding stock by well over two billions of dollars.

The chart (Fig. 3) shows how the price of 10 utility stocks quoted on the New York stock market—all stocks of great utilities in the largest cities—have fluctuated in the last 10 years.

Present Yields on Investments—Interest Rates.—The expressions "investments" and "securities" have been used [illegible] in the broadest sense to cover not only issues of capital stock, i. e., evidences of ownership, but also advances of funds or credit such as bonds, notes, etc., i. e., evidences of indebtedness.

The investing public ranges in character from those buyers whose chief, indeed sole, preoccupation is security of their principal, to those whose prime demand is a high rate of return, even at the expense of safety. The problem before the public utility manager is to determine the form his securities must take in the way of both safety and yield, so that he will make a sufficiently wide appeal both to the conservative as well as to the somewhat more speculative elements in the investing public. The support of both classes in due measure is essential to the successful financing of any enterprise.

Considering first the investor who places security before all, the highest form of investment available to him consists of bonds of the United States Government. These are secured not only upon the property of the body of citizens in the United States, but, in the last analysis, upon the life and honor of every individual citizen. We are unable to conceive of a higher form of security which can be offered to an investor. For securities of this character, which in past years commanded rates as low as 2¼ per cent, 5¾ and 6 per cent, are now being offered. This would appear to establish a minimum figure to be exceeded by all other security offerings in measure based upon their lesser reliability as compared with this maximum of safety.

Taking next the yield upon investments the security for which is more speculative, but upon which the investor seeks for high dividends, it is more difficult to specify an exact figure. Very high figures are often quoted and frequently earned, not only in enterprises of purely speculative character, but also in businesses of a solid and conservative type. From published statements of bankers and others, it would appear that a yield of 25 per cent is not regarded as excessive where the investor subordinates security to the prospects of profit. These two figures—the former definite and the latter somewhat elastic—may be taken as indicating the limits of the investing market in either direction as it must be faced by the public utility manager.

As to interest rates, all money borrowed at the present time is being loaned at far higher rates than have heretofore prevailed in the money market. Time money, borrowed on commercial paper, which formerly commanded interest rates of 4 and 4½ per cent, today fetches 8 and 8½ per cent. Weighty testimony has been given before public utility commissions by bankers and others to the effect that public utility bonds, where saleable at the present time to investors, must net to these investors not less than 7½ per cent, and will, therefore, cost the borrowing utility 9 per cent and over.

How the Rate of Return is Arrived At. Anyone who consumes midnight oil reading decisions in rate cases might fall into the error of thinking, as a result of extended treatment therein of the subject of rate of return, that commissions actually awarded and set aside a certain definite rate of return to the utility whose rates are adjudicated. In point of fact, this is not what happens. The commission, after discussing the general subject, specifies a certain rate which will meet with its approval. But, in large measure, its entire discussion and findings under this head are somewhat abstract.

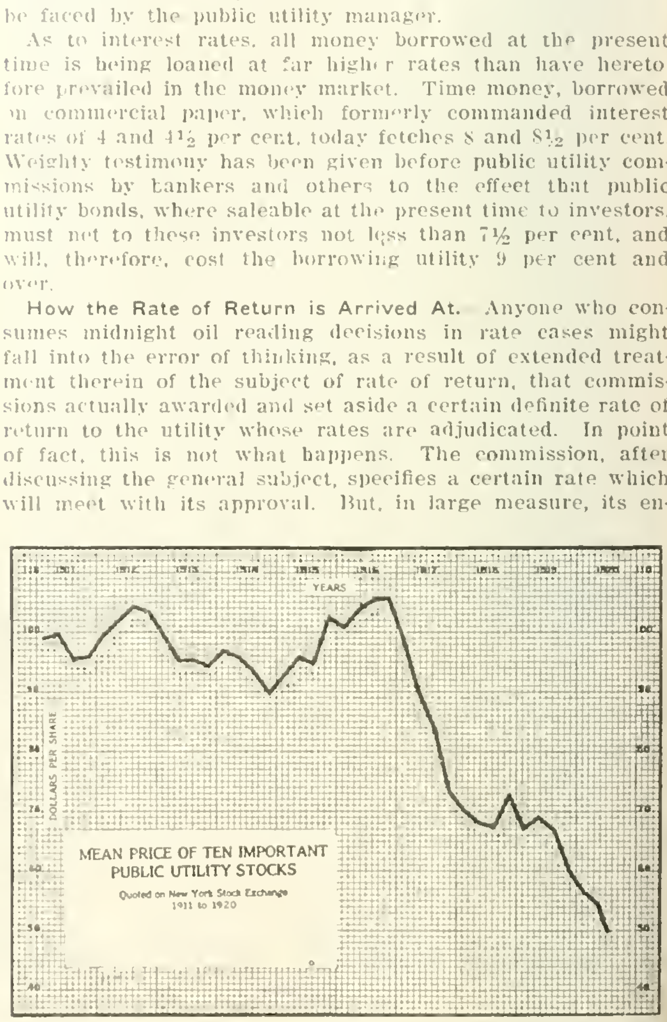


Fig. 3—Mean Prices of Ten Important Public Utility Stocks.

All that is definitely decided upon and awarded is a schedule of tariffs which the utility may charge for the service it renders. What rate of return will accrue to the company's investors therefrom is little better than a guess. With a fixed set of tariffs we can estimate the gross revenue for the ensuing year by making guesses as to both the nature and extent of the business which the company will transact. After we have made these first guesses we must superimpose a further guess as to future operating expenses. Only after this can we form an opinion as to the net earnings the company may anticipate.

if the commission's guesses as to the future business and its guess as to the future operating expenses, together with the tariff schedule awarded, produce the rate of return stated to be desirable, well and good. If it fails to produce it the company stands the loss.

In spite, therefore, of any language in rate decisions specifying a desirable or permitted rate of return, this does not insure it to the company. If, as sometimes happens, much larger business is anticipated at the time of the decision than the company later enjoys, it will not be received. If, in a spirit of optimism, operating expenses are estimated at too low a figure, the rate of return again will show the ill effects. Assuming, however, that some return has been earned, and that the sum, large or small, is available for distribution, the following are the purposes to which it is devoted:

1. To meet interest requirements upon funded and unfunded debt.
2. To amortize or discharge maturing obligations.
3. To so compensate the owners of the utility for
   (a) their services
   (b) the use of their property as to deal justly with them as merchants and public servants, and to make their enterprise sufficiently attractive so that investors and operators shall be attracted to the field of public utilities.

It will be well to glance briefly over each of these in turn.

Interest on Funded and Unfunded Debt. This item involves a recognition of the conditions affecting not only public utility operators, but every business man who has occasion to borrow money or make use of credit facilities. Such a business man must have regard, among other items, to the following features:

(a) Actually meeting his interest requirements.

(b) Maintaining such a margin of net earnings above mere present interest requirements as will not impair his standing among borrowers and users of credit as a class.

(c) Knowing the present and intelligently anticipating the probable future money market, in order to make the best possible arrangements both in the quantity and method of his borrowings.

(a) Failure to meet interest requirements when due, requires little comment. Such failure involves not merely a collapse in the credit of the enterprise, but its financial ruin. The matter of operation upon such a basis is not, and should not be, a practical question.

(b) One of the financial customs which prudence has dictated is that the borrower shall show a margin of earnings over and above interest requirements varying in extent according to the hazards of the business. If the borrower be a municipal or state government, the security of the loan, being based upon the whole political body, and therefore regarded as in effect absolute, may be so small as to be negligible. If the borrower be a merchant engaged in a fairly hazardous enterprise, the lender may insist upon his earnings showing a margin of three or five times the interest requirements, or even more. Merchants engaged in extra-hazardous callings may be unable to obtain credit on any terms, no matter how many times their earnings exceed interest requirements. Public utility enterprises, based upon past experience, appear to require a margin of not less than twice the interest requirements. In spite of much that has been written upon this point, this margin, whatever its extent, does not form a proper criterion for computing the proper return upon the property as whole. It is merely one of several elements which must be considered and which must be given its due weight in arriving at a fair conclusion.

(c) The property manager must not only be well acquainted with the present condition of the money market, but the welfare of the company may depend upon his ability to intelligently forecast its future action. If, by misfortune or poor judgment, a large fraction of his funded or other indebtedness falls due to be refunded at a time when money rates are high, the company will suffer in consequence. If such refunding or re-financing falls due at a time when, owing to stringency, panic or other cause, refunding is impossible, his company may face serious consequences. If, when money rates are high, he puts out an issue of long-term bonds, the burden of interest thereon may be imposed upon his company years after other utilities are obtaining money at cheaper rates. Further, if he has permitted the admission of unwise or stringent provisions into a bond mortgage, he may find himself hampered materially as to the extent of his further financing [illegible] the form [illegible] it must take.

Amortization of Debt.—A [illegible] is a duty the discharge of which [illegible] essential with the meeting of interest requirements. Failure to meet this requirement [illegible] penalty of bankruptcy visited upon failure to meet interest requirements, with the exception that where amortization is not compelled by the terms of a mortgage or similar instrument, relief is frequently had by the renewal or refunding of the indebtedness. This is usually open to the following two objections:

(a) The exaction of a discount for the renewal of the loan, an increase in the interest rate, or very probably both of these items.

(b) The distaste evinced by bankers and financial institutions towards borrowers whose loans are constantly renewed and must be carried continuously, as compared with borrowers, such as industrials, whose loans are liquidated within a reasonable time, thus releasing funds for other enterprises.

It must be recognized as a quality inherent in public utilities, as compared with other businesses, that, where successful, there is ordinarily little prospect of a reduction in the total investment in them. A healthy utility shares in the growth of its community, and is usually an important factor in producing that growth. The larger communities, for instance, could not exist upon anything approaching their present scale without electric railways. The utility, and the investment in it, is, therefore, continuously growing, and this fact, which, on its face should be a strong factor in its favor, may actually place it in a relatively disadvantageous condition in the money markets of the world. It may be unfavorably compared by certain bankers or investors with industrials and other enterprises in which accruing earnings may at any time be diverted to the extinguishment of debt or retirement of invested capital. Recognition of this disability is an important present need.

Return to Stockholders of Public Utilities.—It is essential to realize that none of the items covered in the preceding sections in any way compensate the true owners of the public utility. They deal solely with the requirements needed to satisfy the creditors of the utility and to insure unimpaired maintenance of that credit. Bondholders and noteholders are not owners of the enterprise; ownership resides solely in the stockholders of the corporation. Wise public administration requires clear recognition that these enterprises, like all others based upon the capital and effort of private individuals, rely:

(a) Secondarily upon advances of capital by investors whose real interest in the enterprise is limited, and whose main concern is the safety of their funds.

(b) Primarily upon the initiative, skill, vigor and loyalty of the enterprisers and operators, who rely for their chief reward upon the growth and success of the enterprise over and above its ability to merely support its burden of debt.

Regulation of public utilities which fails to protect bondholders and creditors will, of course, lead to ruin. Nevertheless, regulation carried out solely with an eye to protecting the lenders of funds can never bring about real success or a healthy condition in the utility business. The vast wealth of the United State, the immense strides in industrial progress which it has made, the extraordinary speed evidenced in the development of its natural resources, the whole fabric of its present-day civilization, did not result solely from the availability of funds for investment. Such funds have equally been available for use in parts of the world where no such impressive progress has been recorded.

Success has sprung in large measure from the leadership of great captains of industry, ably supported by loyal organizations of co-partners and workers. All of these men are free agents, able to devote their efforts, their enterprise and their capital to whatever line of activity they may elect. If in the public utility field they are cut off from prospects of gain commensurate with those which they can anticipate in other lines, it is inevitable that they and their associates will desert public utilities and betake themselves to avenues of progress where they obtain adequate reward. Such a result will be a lasting disaster not merely to the industry but to the entire country.

Present Regulatory Methods.—Comment has been made above as to the present-day interpretation by the public of the powers of public utility commissions, as intended for use solely in a quasi-judicial or restrictive sense. A public benefit will result from drawing attention to the fact that there is little or nothing in the laws creating public service commissions which compels action solely in such a sense. Further, this method of regulation is inherently defective, in that it creates a divergence of interest between a utility's investors and its public. The public are led to regard every payment of dividends to the investor as a burden upon the price paid for service, while the investor sees in every reduction of rates an elimination of anticipated earnings. This divergence of interest need not exist.

Perhaps the most revolutionary step in the history of public utilities will occur when the public realizes that neither the spirit nor the letter of the laws creating commissions in general compel the adoption of any such methods. They are at liberty to adopt totally different devices. Being essentially administrative and legislative rather than judicial bodies, they do not have to operate solely by placing restrictions. On the contrary, they are entirely free to afford utilities the chance of continuously increasing profit, where this can go hand in hand with improved service to the public. The laws creating at least 10 public service commissions recognize this feature in specific terms.

Just as soon as regulation passes from the stage of merely limiting earnings to the wholesome stage of offering continuously expanding earnings in return for continuous improvement in service (including rates), public utility securities will begin to command a high degree of public favor. With regulation of this character they will deserve this favor, because they will combine the solidity and conservatism inherent in the public utility business with that prospect of reasonable increase in earning power which every healthy business must have, and these two qualities will make them ideal securities in the eyes of investors.

It is to be clearly understood that nothing in this section, or anywhere in this entire paper, in reference to public utility commissions, or their practices, is written in either a critical or a hostile sense. Everything contained herein is offered solely in a spirit of constructive criticism and with a full recognition that these bodies are acting fairly and with wisdom in dealing with the difficult task before them today. The weaknesses which have been pointed out in our present system of regulation of commerce are the main cause of the perplexities of utility managers today. For this defective system all of us are responsible. Commissions have but interpreted the law as it came to their hands. Some may feel that commissions might be more indulgent to the utilities companies, but plenty of others will be found to regard them as having been, if anything, over-indulgent. The truth is that they have acted wisely and with intent to be fair. Our trouble lies, in considerable measure beyond their reach. Only an enlightened and instructed public opinion will cure it.

Conclusions.—The extensive ground covered in the foregoing pages may be summed up as follows:

(1) Setting aside commerce regulation during the war period, utilities are today completely regulated and practically all other industries unregulated. The grounds alleged in justifying this, are wholly unsatisfactory.

(2) Professional specialization, the existence of separate tribunals for utility matters and other elements tend to make many citizens ignorant of, or indifferent to this discrimination against them.

(3) War-time universal regulation of commerce, including prices, had hearty public approval. Some find it necessary to invent far-fetched excuses for this regulation, the general public does not. The policy had the public's hearty support and so would a continuation of it.

(4) The present custom of regulating only utilities is defended on alleged historical grounds, particularly as to commerce regulation in the Middle Ages and the practices sanctioned by common law.

(5) Actual research into this period proves that much of this pseudo-history is directly contrary to the fact. Commerce regulation was then complete, nation wide and highly developed. Regulation in this country in the seventeenth, eighteenth and first half of the nineteenth century has followed the same general lines.

(6) Present-day practice in the United States is not in accord with historical precedent. The change is contemporary with the great body of ineffective anti-trust litigation under the Sherman Act.

(7) What the public desires is protection from possible extortion or abuse. Sherman Act litigation, successful or otherwise, never could protect the public along these lines.

(8) State legislation in regard to capital security issues, has not achieved its purpose and is a source of hardship and inequality. Utilities are especially and injuriously affected.

(9) The troubles of utilities in the money market grow out of our dual standard of commerce regulation. Utilities are regulated, the money market is not. Commissions cannot compel investment. Utility security offerings must attract investors or they will fail.

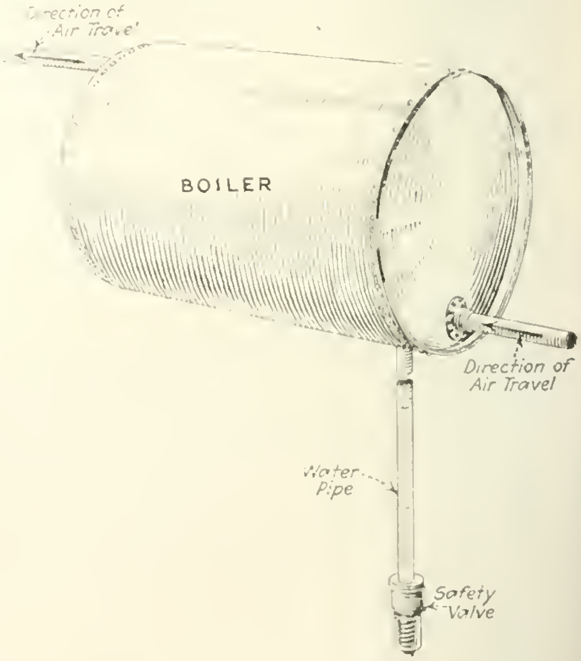
(10) In rate decisions, though the commission may approve and specify a rate of return, the utility has no certainty of receiving it.

(11) In regard to rate of return and regulation generally, attention is too often centered on the bond and note holder and not enough recognition given the stockholder—the true owner of the property.

(12) Present regulatory methods might well give place to others offering progressively greater profit for progressively improved service to the public. There is every opportunity for the development of this special feature.

Removing Water from Compressed Air for Drilling Operations

The presence of water in compressed air is one of the principal causes of machine-drill repairs, owing to the fact that water in the air, in a few strokes of the machine, replaces the oil, leaving the drill to run without lubrication until the machine is again oiled; but even then, it is only a short time until the machine is again divested of its lubrication. This is a source of loss of time as well as money, and the obvious solution is to remove the water from the compressed air. One method of accomplishing this is described by Mr. G. L. Schmutz in a recent issue of Engineering and Mining Journal.

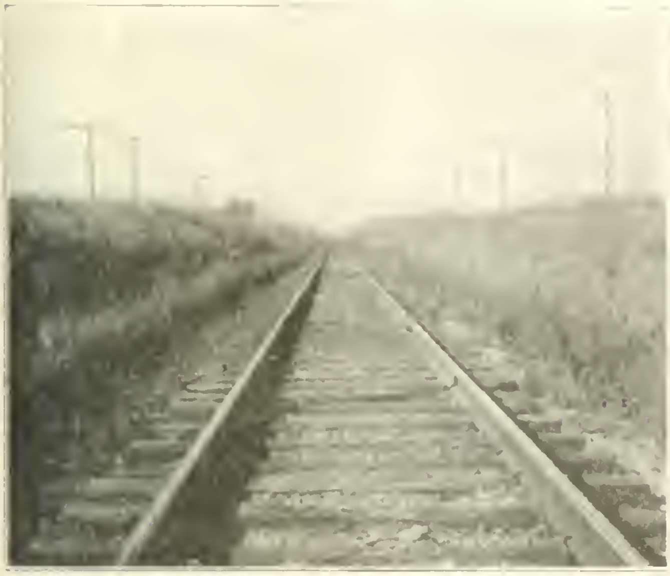


Arrangement of Boiler in Main Air Line.

This method consists in incorporating an old steam dome, or boiler, into the main air line leading away from the compressor, at a sufficient distance from the compressor to permit the precipitation of the humidity in the air. The air line enters the bottom of the boiler and passes out through the top at the other end, the boiler being used as a catch basin for the precipitated water. To dispose of this water automatically a 2-in. pipe leads away from the bottom of the boiler and down an old winze, or down the sides of a hill. On the end of this water-discharge pipe a safety valve was connected, set to open under a pressure of 100 lb. At all times, when there is air in the line, there is a pressure of 90 lb. (any other suitable gage pressure would do) exerted against this safety valve, and when the column of water in the discharge pipe becomes sufficient to weigh 10 lb., making a total of 100 lb. exerted on the valve, it opens, thereby automatically releasing the water from the air line. Operation and maintenance involve no expense.

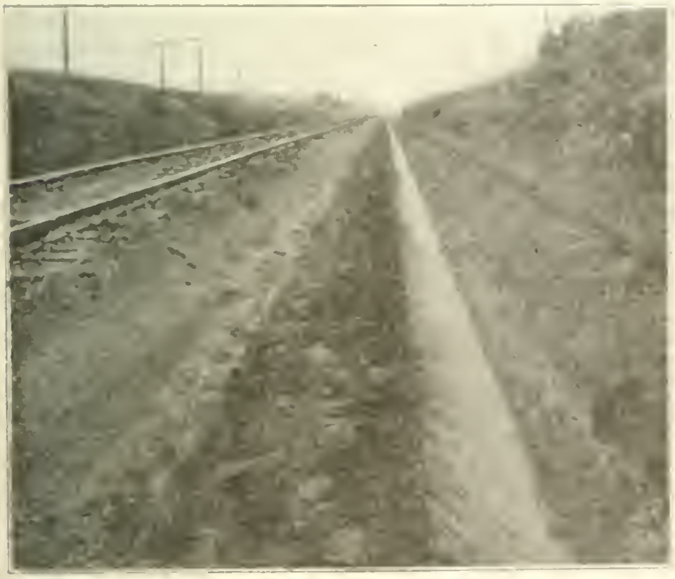
Railroad Ditching with Jordan Spreader

Tests of a Jordan spreader equipped with [illegible]tion ditch scraping wing and bank building attachment were made recently on the Chicago, Rock Island & Pacific Ry. near Bureau, Ill. The machine used was an old spreader that had been in service for about [illegible]. It had been returned to the shops of the O. F. Jordan Co., East Chicago, Ind., and had the right spreader wing replaced with the new combination. On Aug. 25, the machine was put in operation in a deep cut a little below Bureau Junction, Ill., where a clean ditch was scraped through about 500 ft. of wet cut which had constantly presented difficulties in drainage from the fact that several springs empty into it. This heavy muck was easily pushed ahead by the machine, leaving a clean-cut ditch behind, at the rate of about five miles per hour.



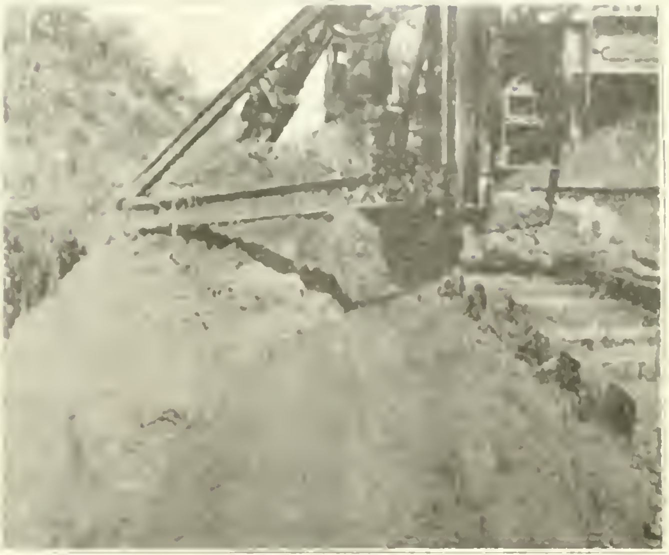
Appearance of Track Before Being Dressed by Jordan Spreader with Ditching Attachment.

Further on the machine was used for trimming the ballast and shaping the bank along a stretch of track. This was done for a distance of 3 miles at a speed of about 10 miles per hour. The machine left both bank and ballast in excellent condition and entirely free from weeds.



Same Track After Being Dressed.

The main operation of the day was in a deep cut adjoining a narrow fill near Henry, Ill., where 700 ft. of ditch were scraped in about 3½ hours. The average amount of dirt removed per lineal foot was about a cubic yard, so that 700 yd. were moved by the [illegible]. The spreader pushed this dirt to the [illegible] where it was used to strengthen the embankment. The [illegible] that the dirt was carried was [illegible] ft. and the time required per round trip about 3½ minutes, including the [illegible] of the ditching wing and the stopping and reversing of the [illegible] train. The cross section of the ditch was [illegible] from the center line of the track. The [illegible] ft. below track level, and the slope of the ditch was 1½ to 1, ballast shoulder 28 in., berm [illegible] ft. [illegible] in. and the width at the bottom of the ditch 1 ft. 6 in. At no point in any of the day's operations was the ballast fouled to the least extent. In operating several immovable obstacles, like huge boulders, were encountered, but the spreader proved flexible enough to clear these. The completed ditch was clean, of even cross section and depth.



Ditching Attachment Pushing Dirt in Ditch Cleaning Operation.

The cost of the operation in the deep ditch, as estimated on the ground, was approximately 7 ct. per cubic yard.

Only an operator for the ditcher and the train crew were necessary, there being no need of teams or any hand shoveling or other kinds of finishing work.

Moving a Steam Shovel Across Country with Motor Truck

A steam shovel needed for heavy grading on a road job in St. Mary's County, Maryland, has recently moved over country roads a distance of 29 miles in less than 2 days. How this was accomplished is told by Mr. Daniel J. Hauer in a recent issue of Successful Methods.

To carry the shovel under its own power meant from 3 to 5 days' time with considerable cost. One man offered to deliver it to its destination with a tractor for $300. The contractor decided to use another method. He hired a 5-ton truck. The steering gear was taken off and the shovel and the rear axle of the truck were connected by means of two short link ¾-in. chains, one fastened on each side. A space of about 5 ft. was left between the bodies of the two machines. The boom was swung to the center and the dipper dropped into the bottom of the truck body. Steam was kept up on the shovel to assist the truck in going up hills.

The shovel engineer went ahead of the truck in a pilot car, coming back to run the shovel up the hills. The first day's run was mostly over bituminous macadam roads and the second day was over gravel and dirt roads. The start was made at 9:30 o'clock in the morning and by 8 o'clock that evening the shovel had covered 18 miles. The next day the shovel was under way at 7:30 o'clock and made the remaining 11 miles by 3 o'clock that afternoon. By nightfall it was placed and ready to dig dirt.

The entire cost, including hire of truck, its return to its owners and the wage of engineer and one other man, was less than $100.

Railroad Rates and Efficiency

The following is quoted from a statement by Mr. Howard Elliott, Chairman of the Northern Pacific Railway Co., in the Stone and Webster Journal:

The great essentials of the transportation machine should be put in complete repair and increased in capacity and number before money, men and material are used for nonessentials that are desirable, but can wait. Trackage, terminals, motive power, cars, both freight and passenger, facilities for caring for equipment, and suitable working conditions for employes are behind the necessities of the country today, and we must prepare now for the next uplift in business.

It is to be hoped, therefore, that prosperous, progressive and ambitious communities will not assume that the rate decision of the Interstate Commerce Commission furnishes unlimited money for things like elaborate passenger stations, grade separations and other non-essentials, and that they will not make insistent demands that such projects be undertaken at once. Every dollar that the railroads can save under the new rates and under the new wages will be needed to make payments for interest, taxes and reasonable dividends, so as to sustain their credit, and to do the essential work above outlined, so that the commerce of the country can be moved satisfactorily. Desirable but non-essential work should, in the interest of the country as a whole, be postponed until we know more about the results to be obtained under the new conditions.

The law and the Commission both say that operation must be honest, efficient and economical. This, however, can only be accomplished by having individual consumers and producers of transportation honest, efficient and economical. As citizens, it is to be hoped that all railroad users and workers will carry out the spirit and the letter of the law, and will help the country by working hard faithfully, by conserving transportation, by eliminating waste, and by co-operation to make the railroad system adequate under the new law and the new conditions.

Suppose that the 2,000,000 men in the railroad service, from the water boy on the extra gang to the highest executive, could save 5 ct. a day, by greater and more intelligent effort, by greater care of plant, materials and fuel, by the elimination of waste, and the adoption of improved methods, the total saving would be $30,000,000 for a 300-work-day year. This is enough to buy 400 heavy locomotives, or 10,000 freight cars. Suppose only an average of 1 hour a day could be saved by shippers in loading and unloading the 2,400,000 freight cars; this time for a 300-work-day year would be 720,000,000 car hours, or 30,000,000 car days, or 100,000 cars per year added to the available supply of the country without the investment of new capital.

News Letter

ST. LOUIS ITEMS.

By A. B. Koenig.

[illegible] Bros. have moved their team outfit on to an Illinois Central R. R. job near Peotone, Ill.

J. J. [illegible] will finish his work at La Plata, Mo., this week. Wants a new job suitable for a 16-team scraper outfit.

The contract for doing road work on the State Highway leading [illegible] Nelliger has been awarded to William Stocker of Webster [illegible], Mo., whose bid of $16,730 was the only one received. This [illegible] the engineer's estimate. The work will include the reducing of the famous Pennyroyal Hill at which point the road will be [illegible].

[illegible] Bros. are in the market for a job for their 10 team outfit [illegible] will finish at Nelson, Ill., on the Chicago & Northwestern R. R. in a couple of weeks.

Contracts totaling $295,484 were let in Granite City, Ill., for the building of the Community High School. The construction work was awarded to the R. B. Higgins Construction & Supply Co., of St. Louis, whose bid of $198,781 was $31,000 less than the next nearest competitor. The heating contract was let to Berdner Plumbing and Heating Company, Granite City, Ill., for $68,000, the plumbing contract to the Boyd Plumbing and Heating Company, Granite City, for $17,523, and the electrical contract to the Newberry Electric Company of St. Louis for $11,180.

Thos. L. [illegible], Jr., Earlham, Iowa, has some bridge filling to sublet on the Chicago & Northwestern R. R. in Iowa.

J. W. McMurray Contracting Co. of Kansas City, Mo., were low bidders for two subways that are going to be constructed by the M. K. & T. and W[illegible] Railroads in Moberly, Mo.

I. J. Printy has finished his work at Columbus, O., and is moving his 25 team grader and team outfit into St. Louis. Wants to place them on some work in this neighborhood. Address him care of Koenig Labor Agency, St. Louis, Mo.

P. J. Hennen Co., St. Louis, Mo., is going to build five miles of line in to a clay bank near Jonesburg, Mo., for the Walsh Fire Clay Co.

Contractors when in want of labor or work for their outfits write, wire or phone Koenig Labor Agency, 612 Walnut St., St. Louis, Mo., 702 Delaware St., Kansas City, Mo., or 1020 Douglas St., Omaha, Neb.

Personals

H. Lee Wilson has been appointed city engineer of Johnstown, Pa.

W. C. Allen has been appointed assistant valuation engineer of the Fort Worth & Denver City Ry. and the Wichita Valley Ry., with headquarters at Fort Worth, Tex.

W. S. Higgins has been appointed division engineer of the Galveston, Harrisburg & San Antonio Divison of the Southern Pacific Ry., with headquarters at Victoria, Tex.

H. M. Trippa has resigned from the engineering department of the Wisconsin Railroad Commission to accept a commission as major in an engineer regiment of the U. S. Army.

George H. Lautz of the U. S. forest office, District No. 1, in Missoula, Mont., has been appointed assistant engineer of the forest service with headquarters in Washington, D. C.

George W. Gillette, superintendent of railways of the Tide Water Power Co., Wilmington, N. C., has been commissioned in the engineer corps of the regular United States Army with rank of captain.

W. H. Lord has resigned as chief engineer of the Jacksonville (Fla.) Terminal Co. to assume an office in the department of railway valuation of the Interstate Commerce Commission, with his headquarters in Chattanooga, Tenn.

Colonel Henry C. Newcomer has been appointed division engineer of the United States engineering department, with headquarters in New Orleans, to relieve Colonel Herbert Deakyne, ordered to report to San Francisco for duty.

J. C. Stevens and R. E. Koon have organized the firm of Stevens & Koon, consulting engineers, with offices in the Spalding Bldg., Portland, Ore. They will specialize in matters pertaining to municipal improvements, water supply, sewerage, irrigation, hydro-electric power, appraisals and valuation.

Sidney W. Cooper has accepted a position as assistant division engineer, 4th Division, Alabama Highway Department. Since the close of the war Mr. Cooper has been connected with the New Jersey State Highway Department. During the war he was with the Construction Division of the Army. Before that he had been, for a number of years, a drainage engineer in the United States Department of Agriculture in charge of work throughout some of the southwestern states. The 4th Division of the Alabama Highway Department covers about one-fourth of the state extending west and south from the center of the state. Division headquarters are located at Selma, Ala.

Louis V. Bean has been appointed chief engineer of the Georgia, Florida & Alabama R. R., with headquarters at Bainbridge, Ga. Mr. Bean entered railroad service in 1907 as rodman in the office of the division engineer and road master of the Cincinnati, New Orleans & Texas Pacific Ry. In May, 1909, he came to the Central of Georgia as draughtsman in the office of the chief engineer at Savannah. He was appointed resident engineer in February, 1910, and assistant engineer in 1911, remaining meantime at Savannah. He resigned on Nov. 1, 1911, to become second assistant engineer to the engineer of roadway of the Atlantic Coast Line, with headquarters at Savannah. In 1915 he was promoted to first assistant engineer. He served with the building division of the construction division of the United States Army from July, 1918, to July, 1920.

Col. James A. McCrea, for the past two years vice president of the Bankers' Trust Co., New York, has been appointed vice president of the Central region of the Pennsylvania R. R. Col. McCrea is a son of the late James McCrea, president of the Pennsylvania R. R. He entered the service of the Pennsylvania in 1895 as rodman. A year later he was transferred to the maintenance-of-way department of the Cleveland and Pittsburgh division, and in May, 1897, was transferred to the lines east, on the Philadelphia division. In May, 1898, he became assistant engineer of maintenance of ways. In June, 1901, Col. McCrea was returned to the western lines and promoted to superintendent of the Cincinnati division, where he remained until 1906. In January of that year he was transferred to the Long Island Railroad as general superintendent and in November, 1911, became general manager occupying the latter position when he went to France with General Atterbury in 1917.

T. W. Norcross has been appointed as chief engineer of the U. S. Forest Service, succeeding O. C. Merrill, who resigned a short time ago to become executive secretary of the Federal Power Commission. Mr. Norcross is a native of Medford, Mass., and a graduate of Tufts College, from which institution he received in 1901 the degree of Bachelor of Science. After his graduation from college he had several years of general engineering experience, particularly in hydraulics and construction work. He was also employed by the Geological Survey on hydrographic work, and in October, 1910, entered the Forest Service as district engineer of the Rocky Mountain and Southwestern Districts, with headquarters at Denver, by transfer from the Geological Survey. While district engineer, Mr. Norcross was in charge of the waterpower and irrigation studies made by the Forest Service, as well as other general engineering work in the two Forest Service districts. In June, 1915, he was transferred to the Washington office to take the position of assistant chief engineer, and since 1916 has devoted his attention almost entirely to the supervison of National Forest roads constructed with the appropriations made under the 10 per cent fund, Federal Aid Road Act, and the Post Office Appropriation Act of 1919.

Industrial Notes

The American Engineering Co., Philadelphia, Pa., has opened a new office in Cincinnati, for the purpose of extending Taylor stoker representation and service. M. M. Masson is in charge of this office at 207 Neave Bldg.

R. A. Bull, of Pittsburgh, has been appointed consulting metallurgist for a number of prominent steel foundries grouped for the purpose of developing and perfecting higher standards in the production of steel castings. Mr. Bull will devote his entire time to preliminary research work immediately and has resigned his position as vice president of the Duquesne Steel Foundry Co. The members of the group include: Electric Steel Co., Chicago, Ill.; Fort Pitt Steel Castings Co., McKeesport, Pa.; Isaac G. Johnson Co., Spuyten Duyvel, N. Y.; Lebanon Steel Foundry Co., Lebanon, Pa.; Michigan Steel Castings Co., Detroit, Mich.; Sivyer Steel Castings Co., Milwaukee, Wis.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 403 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $4 00; any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., OCTOBER 27, 1920. Number 17.

Should the State of Texas Engage in Portland Cement Manufacture?

When an engineer undertakes to estimate the cost of producing a manufactured article, he should take special care to ascertain the annual output factor, or the average output rated as a percentage of the annual capacity of the plant. We have before us an estimate of the cost of manufacturing portland cement in which the estimator has assumed that the output factor would be 100 per cent. As a matter of fact the biggest year's output of American Portland cement mills was less than 75 per cent of the total capacity of the mills; and the average output factor over a period of six years was about 66 per cent.

The total capacity of the Portland cement mills of this country is variously estimated at 125,000,000 to 140,000,000 bbl per year. The output by calendar years has been:

Year	Bbls.
1914	89,650,000
1915	86,710,000
1916	92,360,000
1917	93,450,000
1918	71,510,000
1919	80,490,000
Average for 6 years	85,600,000

This annual average of 85,600,000 bbl. is 66 per cent of 130,000,000, which is a conservative estimate of the capacity.

In a paper read before the Texas Road Builders' Association last June, Prof. J. C. Nagle, Dean of the School of Engineering of the Agricultural and Mechanical College of Texas gave the following estimate of the cost of a cement mill of 1,000 bbl. daily capacity:

Buildings	$165,000
Machinery and power plant	310,000
Quarry equipment	25,000
Industrial tracks	15,000
Total	$515,000
Interest at 6%, assuming 12 months for construction	$ 15,450
Organization expense, assumed at 5%	25,750
Contingencies, assumed at 10%	51,500
Total overheads	$ 92,700
Total construction cost	$607,700

Prof. Nagle estimated the annual fixed charges and operating expenses as follows:

Interest at 6% on $607,700.00	$ 36,462
Depreciation at 5% on $515,000.00	25,750
Labor and superintendence	100,000
Fuel oil (100,000 bbl. at $3.50)	350,000
Power (1 hp. per bbl., or 1.5 ct. per Kw. hour)	81,000
Repair parts and general supplies	45,000
Total estimated annual operation cost	$638,212

Prof. Nagle then assumed an output of 300,000 bbl. per annum, which is equivalent to a full 100 per cent capacity output every working day in the year. This would result in a cost of $2.13 per barrel. He estimates that the average mill price is 34 to 45 ct. per barrel in excess of this estimated cost of $2.13. But let us see what the estimated cost would be were the output factor 66 per cent, or in this case about 200,000 bbl. per annum instead of 300,000. His interest and depreciation charges then would be 31 ct. per barrel instead of 21 ct. Fully 40 per cent of the wage and salary expense would remain unaffected by changes in the output factor, so that it would cost 7 ct. more per barrel for wages and salaries under a 66 per cent output factor than under the 100 per cent output factor assumed by Prof. Nagle. Hence even under a high output factor of 66 per cent there would be a cost of fully 17 ct. per barrel higher than that estimated by Prof. Nagle.

Prof. Nagle tacitly assumes his estimate of cost of production of cement to be complete, for he goes on to estimate that the state of Texas could save at least $102,000 a year over the lowest existing market prices were it to own and operate such a plant. We fail, however, to find any items to cover insurance, taxes, lighting, miscellaneous office and general expense. A state owned plant would not pay taxes, but by as much as it did not do so it would throw the tax burden upon other property and thus upon the public.

We note that electric power is estimated at 1.5 ct. per kw. hour, which is too low. It is true that such a rate for high load factor service is still to be had in Texas, but public utility power companies are struggling to secure rates that will be remunerative, and with $3.50 oil no such company can live when the power rate is 1.5 ct. per kw. hour even for high load factors. Assuming 230 kw. hours at the bus-bar per barrel of oil, the cost of oil alone is 1.52 ct. per kw. hour without allowing for losses in transmission and transformation

It is not our purpose to analyze in detail Prof Nagle's estimate, but rather to point out the error in using an output factor of 100 per cent. This sort of error is still very common among engineers. There are, for example, numberless printed estimates of the cost of generating power in which the estimator has not only assumed an excessively high load factor, but has failed entirely to allow for the standby or emergency equipment needed to give continuity of service during peak load hours.

We have made no reference to the well-known fact that publicly owned plants are rarely operated with as high a degree of economy as are privately owned plants. Taking this into consideration, it is apparent that the state of Texas has nothing to gain by engaging in the production of cement, even though, as Prof. Nagle estimates, 1,000,000 bbl. will be annually used in road construction. Prof. Nagle says at the close of his paper:

> The principal effect of a state owned plant would, however, lie in its wholesome tendency to stabilize market prices and reduce fluctuations which, when excessive, are hurtful to both producer and consumer.
>
> I leave it to each of you to decide whether or not, in your opinion, the state should own and operate a cement plant of its own and hope that what has been said may aid you in reaching a conclusion.

State-owned cement plants, if built to regulate prices, would probably result in the extermination of privately owned plants, and thereafter the cost of cement, would be "regulated" by politicians and their appointees.

Why Taxes for Public Works Should be Increased

If there is to be no decrease in the volume of public works construction there must be an increase in taxes. A dollar today will buy less than half a dollar would buy six years ago, yet taxes have not risen proportionately. The consequence is that although the annual appropriations for public works are as large as during prewar years, they are relatively small in buying power. Taxpayers have been hoping against hope that construction costs would recede to the prewar level. Political office holders have encouraged this hope. But it must now be growing apparent to all that the hope is vain.

The peak of wholesale commodity prices was reached in May when the index price was 272, as compared with 100 for the year 1913. Since May there has been a steady and rapid recession of wholesale prices, the index for September being 242, or 11 per cent below the May peak. Those who have not closely followed this change in the price level will be surprised at the relatively small decrease in the past four months. At the present rate of decrease—rapid though it is—four more months will elapse before the index price is down to 214, or the average for the year 1919. It is not unlikely that a year hence the index price will have fallen to 175, but thereafter it will decrease very slowly, for reasons that have been given in previous articles, the chief of which is that our per capita currency is 66 per cent greater than it was in 1913.

Construction material prices will probably follow the history of such prices in 1865 to 1873, and remain far above the level of the prices of other commodities. In those eight years (1865-1873), the price of building materials fell only 8 per cent, whereas the average price of all commodities fell 35 per cent. There is little likelihood that hourly wages in the construction field will decrease, but the efficiency of the workers will increase. In fact, it has already increased in many localities.

Civil engineers should begin active campaigns to convince the public not only that nothing will be gained by curtailing construction, but that taxes for public improvements should be increased. Assessed values should be raised 50 to 100 per cent, say an average of 70 per cent, to correspond with the increase in per capita currency and therefore with the new plateau of prices.

What Is the Economic Significance of "Output Factors?"

Electrical engineers have long been accustomed to estimate "load factors" in determining the cost of electric current, but civil engineers have less frequently used factors of this sort. The consequence is that civil engineers frequently estimate unit costs of products on the basis of continuous operation of machines at full capacity. Even where such an extreme error is not made, there is a tendency to use an output factor far in excess of a normal average.

An annual output factor is the ratio of an actual annual output to an annual capacity output. Usually the annual capacity output is based on 300 working days, Sundays and holidays being excluded. Whether a one, two or three-shift day is used depends on the character of the work. Standby machines, to be used in case of breakdowns, etc., should not be included in estimating the commercial capacity of a plant where output factors are to be determined.

We do not know what the rated capacity of pig-iron furnaces in America is, but under favorable conditions those furnaces have turned out nearly 4,000,000 tons in a month, so that the commercial (not the rated) capacity is nearly 48,000,000 tons annually. For the year ending June 30, 1920, the actual output was 33,170,000, or about 70 per cent of the commercial capacity, which was a good year. In another editorial we show that the output factor of the portland cement mills has averaged about 66 per cent for the past six years, never rising above 72 per cent in the best year. In that editorial we pointed out an error made by an engineer estimating the cost of portland cement, because of his use of a 100 per cent output factor.

Having determined an average annual output factor for a term of years, the next step is to estimate what annual costs are independent of output factor variations. That is the fixed costs. Unless the plant is closed down completely and all the employes discharged, there is usually a large percentage of the pay roll that remains unaffected by the output factor. While repairs usually decrease to some extent as output decreases, the depreciation annuity usually decreases inappreciably. Taxes and fire insurance usually remain unchanged, and, of course, interest on the investment runs on regardless of output.

In operating a power plant the thermal efficiency of the boilers and engines decreases as the load factor decreases. This is frequently forgotten in calculating the economic effect of operating a plant at less than full capacity. Even where the power is purchased, higher rates are usually paid under lower load factors.

The larger the plant investment, proportionate to the total annual cost, the more important is the element of fixed costs, and the more careful must the engineer be in estimating the output factor. An error of a few per cent in the output factor may change the unit cost sufficiently to vitiate all the inferences.

Cost of Accident Prevention in Building Construction

The total cost of safeguarding 170 workmen, engaged in the erection of the Balfour Building at San Francisco, for a period of 12 months, was $9,700 or $57.05 per man, according to an article in the California Safety News by J. J. Rosedale, Construction Engineer of the California Industrial Accident Commission. The building is a 15-story structure. Early in November, 1919, wrecking of the old building and clearing of the site for the new building started, and on Feb 9, 1920, the steel erection was started. The building was 70 per cent completed on July 15, 1920, and was expected to be ready for occupancy by Nov. 1. Up to July 15, 1920, there were only eight slight injuries on this building, and a total of $725 was paid out for compensation. The itemized cost of safeguarding the workers on the building has been:

Planking floors	$3,500
Guarding machinery	500
Guarding stairways	300
Two towers including cages and landings	2,550
Guarding two elevator shafts	300
250 ft. of safety suspended scaffold	3,200
Outriggers' scaffold to protect workmen and the public from falling materials	350

Wood As a Structural Material

Shortly before the war one of our leading bridge engineers made the statement that, in view of the enormous consumption of steel and the multiplying rate at which it was proceeding, the time would come when we should be threatened with a shortage of this material. Among the comparatively modern constructions which have made a heavy inroad upon our supplies of iron ore, he mentioned the towering office, hotel and apartment buildings, which, before the war, were being built by the thousand throughout the country. The enormous expansion in our industries has created a proportionate demand for structural steel; and although the growing use of concrete has served to lessen the demand, the steel re-enforcement foots up a heavy annual total. Although the building trades are passing through a period of stagnation, the reduced consumption of steel, due to this, is temporary and it will be more than counterbalanced by the tremendous demand that will ensue when normal conditions return, and we attempt to make good the arrears of construction.

As for the railroads, the largest part of the billions of dollars which will be required as a consequence of the neglect of the past half dozen years will be spent upon steel in the shape of rails and steel rolling stock. Moreover, the great revival in our merchant marine, which we all hope will prove to be permanent, will call for heavy deliveries of shapes and ship plates—a demand which before the war was insignificant.

All of which suggests the wisdom of casting our eyes about in search of substitutes for steel, which can compete with it in cost and durability; and the first material that comes to mind is the wood of which we still have such a potential store in our sadly depleted but still magnificent forests.

Leaving out of consideration the extensive use of wood for home building, we are apt to forget how greatly we were indebted, in the earlier decades of our industrial progress, to our timber supplies for the construction of our factories, the marvelous post-war extension of our railroad system, and the construction of the famous clipper ships of our merchant marine. As regards the construction of our transcontinental railroads with their many ramifications, it is no exaggeration to say that, had it not been for the superb Douglas fir of the West and the long-leaf yellow pine of the South, the pioneer railroads of the last century could never have been pushed out over the continent at the amazing speed and for the very low cost which characterized their construction.

The Howe Truss timber bridge and timber viaduct—without these our pioneer railroad builders would have been helpless. For in those days, steel mills were few and steel was costly; whereas, once the Mississippi Valley was crossed the engineer found himself within easy reach if not in the very midst of vast forests of the finest structural timber in the world. All that was necessary for the crossing of rivers and the spanning of deep ravines was to erect a sawmill in the adjoining or nearby forest, and send east a bill of steel, consisting of screwbolts for his timber trestles and round bars for the tension members of his Howe Truss bridges, together with some simple castings for the footing of the compression members.

But all that was long, long ago; whereas our object is to suggest that there are many forms of construction in which we might turn once more to wood and get excellent results. Nor should the deplorable outcome of our recent attempt to build a fleet of wooden ships be allowed to shut the door upon wooden shipbuilding. Timber that was standing in the forest one month was framed into a ship the next—and ships that were built of green wood had only one fate in store for them.

But it is far from proved that there is no place for the woooden ship on the high seas. Yacht Designer Nicholson, who has produced a staunch and tight boat in "Shamrock," believes that the multi-ply system can be used on ocean-going ships, and that by sawing the timber into planks for "ply" construction, the wood can be so rapidly seasoned as to make it possible to reduce the time between the felling of the timber and its incorporation in the hull to a practicable limit.

As to the durability of timber, there are county wooden bridges doing good service, even today, that must have seen a good "three score years and ten" of service in the open, and there are timber roofs above the vaulted masonry roots of European cathedrals that have stood untouched and perfectly sound for centuries.—Editorial in Scientific American.

Civil Engineers Would Block Federation

The civil engineers have submitted the question of joining the Federation of American Engineering Societies to their membership by letter ballot. Accompanying the ballot are two letters, one for and the other against joining the federation. The former is a conservative, sane and safe declaration. In the latter the claim is made that because the federation is not perfected the new body can never function properly. The real objection of the A. S. C. E., however, is to be found in this statement: "Should the society join the federation, it would, in the estimation of the public, cease to function as the leading engineering organization, as it has done for 68 years." The reasoning sounds familiar. We recall when the Engineering Societies Building was erected and the Engineering Foundation formed that the same objection was raised. The civil engineers would not join because they had a home of their own and they were afraid of losing their identity. When later it was found that aloofness brought isolation they applied for admission. Who, then, are leaders? Those who do things, those who build! Leadership connotes action, not reaction, and those who would aspire to it must be constructive. The federation to be of value must include all engineers and the "civils" must do their part to make it an effective organization.—Editorial in Oct. 9 Electrical World.

How to Tell Birch, Beech, and Maple Apart

Birch, beech, and maple are very similar in appearance, and have approximately the same weight. Hence it is comparatively easy to mistake one of them for another. A method which anyone can use to distinguish them is suggested by the U. S. Forest Products Laboratory. The method makes use of the relative width of the pores and medullary rays in the three woods.

If the end grain of birch, beech, or maple is cut smooth with a sharp knife and examined with a hand lens, the pores will be seen as tiny holes distributed fairly evenly over the surface, and the medullary rays will appear as narrow lines of a different shade running at right angles to the growth rings.

In beech some of the rays are very distinct even without a lens. The large rays are fully twice as wide as the largest pores.

In maple the rays are less distinct, and the largest are about the same width as the largest pores.

In birch the rays are very fine, invisible without a lens. The pores are several times larger than the rays, usually being visible to the unaided eye as minute holes on the end grain and as fine grooves on dressed faces of the board. The pores in birch are considerably larger than the pores in beech or maple.

The appearance of the medullary rays on a "quartered" surface is also distinctive. Here they appear in beech as distinct "flakes," the largest being between 1/16 and 1/8 in. in height when measured along the grain of the wood. In maple they are considerably smaller, rarely attaining a height of 1/16 in. In birch they are comparatively inconspicuous.

Progress Report on Heat Emission from Various Surfaces.

A second report of progress under the present co-operative agreement between the National Warm-Air Heating and Ventilating Association and the University of Illinois for an investigation of warm-air furnaces and furnace heating systems, has been issued by the Engineering Experiment Station of the University of Illinois as Bulletin No. 117, entitled, "Emissivity of Heat from Various Surfaces," by V. S. Day, Research Assistant. This bulletin deals principally with an investigation of the value of insulating materials commonly employed in warm-air furnace installations, as affecting the economy of the system. Copies of Bulletin No. 117 may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

Another Theory as to How the Pyramids Were Constructed

To the Editor: I was quite interested in reading "A new theory" of constructing the pyramids in the issue of Aug. 7 of The Literary Digest, an excerpt taken from Engineering and Contracting.*

To my mind the theory set forth in the article is as impracticable as building ramps of sand; but granted that the steps or insets were cemented as soon as formed it would take too long even in those days when time was no object for the cement to harden sufficiently to have such heavy weights hauled over it, and even then there would be the probability of having the thinner parts cracked or crumbled, particularly at the corners requiring that entire surface be gone over and patched up. I do not believe such a process was in keeping with the other work of the builders. Then, too, the area for working to advantage would be contracted particularly in placing the outer layers of stones, especially at the corners.

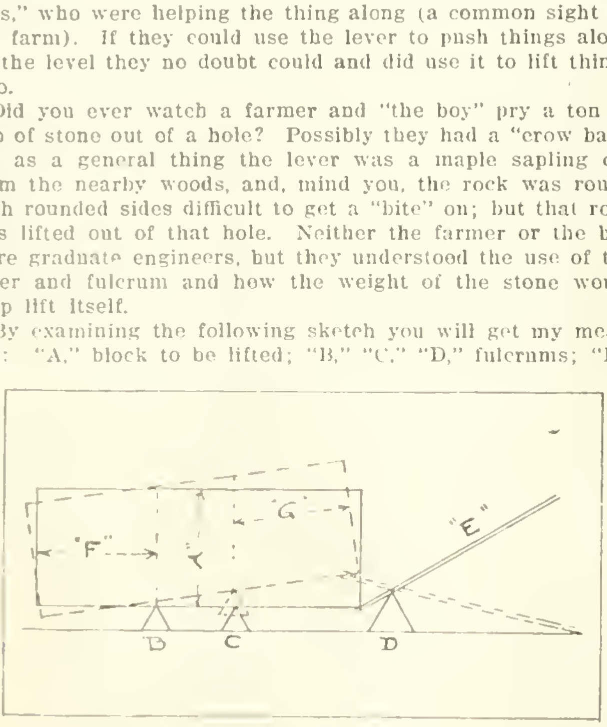
It is my belief, gained as a boy working on a farm, and as a carpenter, with the knowledge resulting from my reading and practice as an architect, that the blocks of stone were raised and placed in position by the very simple process of using the lever and fulcrum, and using part of the weight of the block or stone to help lift itself.

As to the statement that no evidence has come to light depicting any phase in the construction of the pyramids, I would ask that you look over the illustrations showing some of the methods used by the people of those times, and you will see that they understood perfectly the use of the lever and fulcrum.

I remember one picture where a large block of stone was being moved on skids or a "stone boat," hauled by ropes, and in the rear were two men with levers used as "pinch bars," who were helping the thing along (a common sight on the farm). If they could use the lever to push things along on the level they no doubt could and did use it to lift things also.

Did you ever watch a farmer and "the boy" pry a ton or two of stone out of a hole? Possibly they had a "crow bar," but as a general thing the lever was a maple sapling cut from the nearby woods, and, mind you, the rock was rough with rounded sides difficult to get a "bite" on; but that rock was lifted out of that hole. Neither the farmer or the boy were graduate engineers, but they understood the use of the lever and fulcrum and how the weight of the stone would help lift itself.

By examining the following sketch you will get my meaning: "A," block to be lifted; "B," "C," "D," fulcrums; "E," lever; "F," "G," parts of block that help lift itself. When block is raised to limit of lever on fulcrums "B" "D" raise fulcrum "C" to block; during this process the weight "F" will help counter-balance and assist in raising the other end. After fulcrum "C" has been raised apply lever at the other end of the block and the portion "G" will help counter-balance, then raise fulcrum "B" and repeat the process and "see-saw" the block as high as necessary.



The lever could be dispensed with on the longer blocks and the men could act as "candle stick" as we kids used to when we played see-saw, i. e., mass their weight beyond the center of gravity and get some fun out of it. In the case of the pyramids each step or inset would be used as part of the blocking by pushing the stone over on to it, thus minimizing the quantity of blocking by using what had been released over again.

When each successive level was reached the outer edge of the stone would be raised and the stone slid into place on greased skids or on rollers. This method would leave the corners the last to be filled, thus giving two sides or ways to work from, making the most accurate fitting possible.

Gangs of men could work on all four sides, several gangs on a side following up each successive height as reached, thus making comparatively rapid progress. If you could watch the process described or try it yourself you would (perhaps) be surprised at the ease and rapidity with which it is done.

The pyramids built, leaving the steps or insets to be filled later, formed with the aid of very little blocking, good platforms to finish the work from. Cement or polished stones could be used to finish the sides as smooth as possible without going over the entire surface patching up broken and gouged places or other disfigurements. The wood blocking then could be used for fire wood to make sacrifices to the gods, "And all left swept and broom cleaned at completion of the contract."

I presume the builders thought the process of lifting the stones so simple that it wouldn't "pay" to commemorate it by "sculping" it on the walls of the inner chambers. I do not deny but that the building of the pyramids was a big "job," neither do I feel conceited in saying that if I could get some of the old farmers I have known as "bosses" and one-fourth of the men tradition gives, I would take the contract to build another pyramid using the process described.

Take the obelisks, for instance, and what would be more easy than to build blocking or curbing two-thirds the length, brace the foot and gradually with the lever and fulcrum raise them to a perpendicular. Or the erection of "Stonehenge," make a hole in the ground to prevent slipping, raise the supporting stones to a perpendicular and then "see-saw" the horizontal stones to the required height and slide them into place.

Apply this fact, i. e., of having a heavy weight help lift itself, and you have solved the so-called mystery of other great stones being lifted to considerable heights, and how "puny man" (?) with lever and fulcrum has been able to do "stunts" that have kept the world guessing.

EDWY E. BENEDICT.

Waterbury, Conn.

---

*See June 30, 1920, issue.

Drying Lumber with Superheated Steam

A kiln-drying process which will dry 1-in. softwood lumber green from the saw to 10 per cent moisture content in 24 hours or less has been developed at the U. S. Forest Products Laboratory, Madison, Wis. The novel feature of the process consists in forcing superheated steam at high velocity first in one direction and then in the opposite through the pile of lumber in the kiln. This treatment dries the lumber very uniformly and rapidly with a minimum of checking and warping.

The superheated steam process has been found applicable to Douglas fir, firs of all kinds, western hemlock (not eastern), white cedars (not western red), sugar pine, western yellow pine, and southern yellow pine. It is entirely unsuited for some softwoods on account of collapse.

Drying lumber by this process consumes more steam per 1,000 ft. of lumber than ordinary kiln-drying processes, and is recommended only where economy in fuel is not essential. As it is deleterious for lumber to be exposed for more than 2 or 3 days to the temperatures used, the superheated steam kiln is not adapted to the drying of lumber in thicknesses of more than 2 or possibly 2½ in. It should be stated, furthermore, that the treatment somewhat reduces the toughness of the lumber, so that where this quality is of prime consideration, as in airplanes and wagons, a low temperature process of drying should be used. On the other hand, the superheated steam method reduces the "working" of the board and the hygroscopicity of the wood and also "fixes" the resin and gum. The effect upon knots as compared with low temperature drying has not been fully determined, but apparently there is not much difference. A slight darkening of the sapwood occurs, increasing with the length of time of exposure, and in periods much over 24 hours the heartwood may darken also.

Diagram for Flat Slab Design

By O. WOLPERT,

Industrial Department, Thompson Starrett Co., New York City

The following diagram is intended to furnish a ready means for estimating the quantity of steel and the total thickness of slab required for square interior flat slabs, with drop panels, based on the latest regulations of the city of New York, which were published in the July 28 issue of Engineering and Contracting.

To use the diagram, it is only necessary to know the length of span and the superimposed load, i. e., the total applied load per square foot exclusive of the dead weight of the structural slab including the drop panel. No assumption as to the dead weight of the proposed construction need be made as the diagram has fully allowed for same.

In the upper part of the diagram, the set of load curves radiating from the lower left-hand corner, including the broken lines are to be used for finding the minimum thickness of slab permitted by the code. When the intersection of the span length with the load line falls below the upper broken line for floor slabs, and below the lower broken line for roof slabs, the value for the thickness of slab, indicated at the intersection of the span length with the corresponding broken line, is the minimum thickness of slab that may be used.

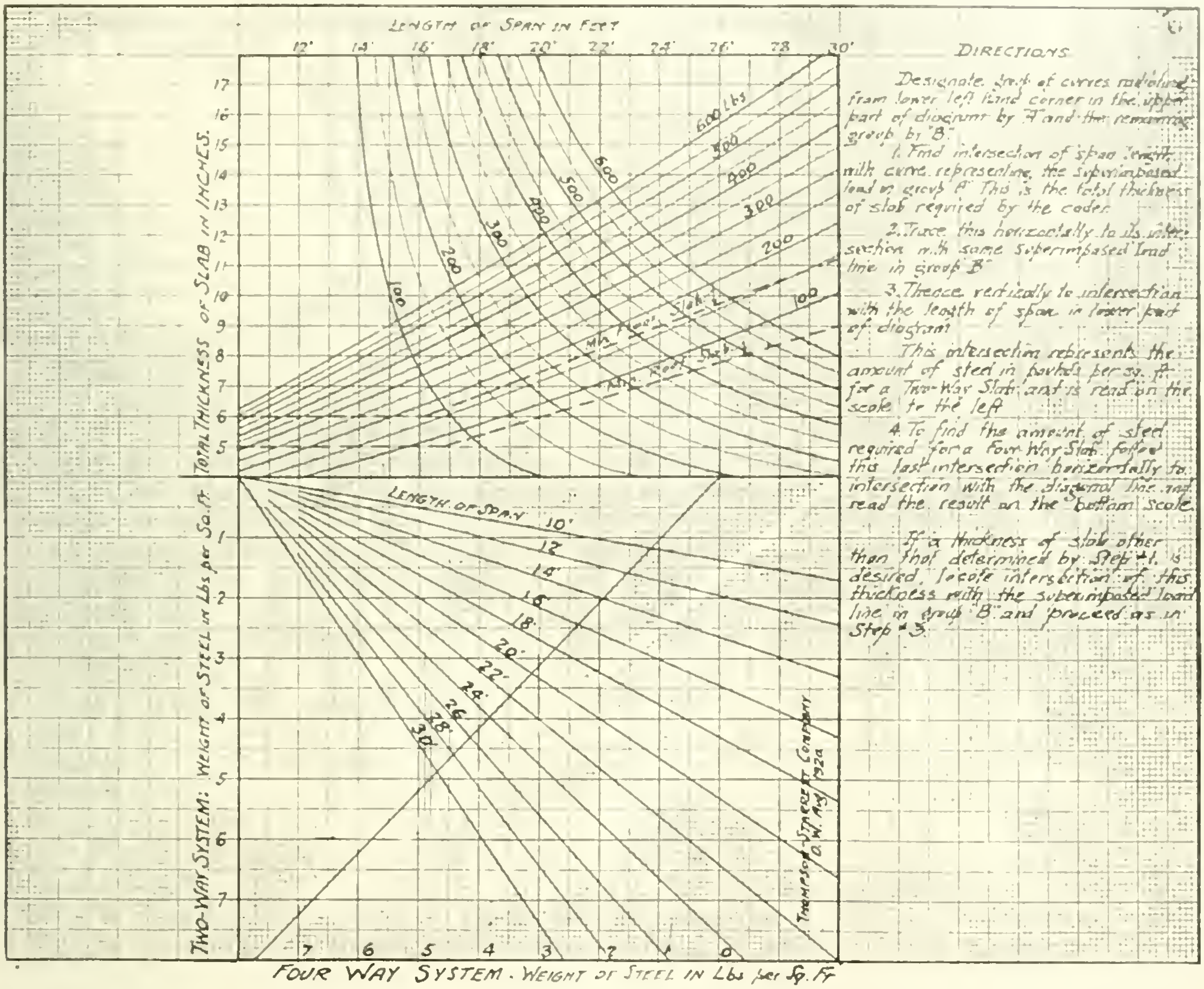
The second load series in this part of the diagram when used in conjunction with the lower part, serves to obtain the amount of steel for any selection of depth and superimposed load. It is therefore necessary to first fix the depth, either by aid of the first series, or by arbitrary selection.

The amount of steel is found by locating the vertical projection of the intersection of the selected depth and load curve of the second series, upon the length of span in the lower part of the diagram, reading on the scale to the left for a two-way slab or by tracing this point horizontally to the diagonal line, and reading on the scale at the bottom, for a four-way system.

The amount of concrete is readily computed from the thickness of slab. The drop panels increase the total volume of concrete in the floor about 4 or [illegible] per cent.

The diagram is the result of an analytic consideration the theoretical amount of steel required for the moment coefficients specified by the code. The expressions thus obtained were modified to compensate for laps, bends, and the selection of commercial bar sizes.

It is believed that the results given by the diagram will be found to closely agree with the results obtained by actual design.



DIRECTIONS

Designate group of curves radiating from lower left hand corner in the upper part of diagram by "A" and the remaining group by "B".

1. Find intersection of span length with curve representing the superimposed load in group "A". This is the total thickness of slab required by the code.

2. Trace this horizontally to its intersection with same superimposed load line in group "B".

3. Thence vertically to intersection with the length of span in lower part of diagram.

This intersection represents the amount of steel in pounds per sq. ft. for a Two-Way Slab, and is read on the scale to the left.

4. To find the amount of steel required for a Four-Way Slab, follow this last intersection horizontally to intersection with the diagonal line and read the result on the bottom scale.

If a thickness of slab other than that determined by Step #1. is desired, locate intersection of this thickness with the superimposed load line in group "B" and proceed as in Step #3.

Diagram for Estimating Amount of Reinforcing Steel and Thickness of Slab Required by New York City 1920 Regulations.

Standardization of Sand Sieves.—During September the problem of standardization of sand sieves was taken up by the U. S. Bureau of Standards, with the object of preparing standard samples for their testing. The Bureau at present maintains standard cement samples for checking 200-mesh sieves and these samples may be used for the determination of correction factors for such sieves thus comparing them with the standards kept at the Bureau. The difficulty in preparing a sample for the standardization of sand sieves is due to the fact that it is almost impossible to secure a material that will remain uniform. In a relatively coarse sample, such as would be required in the testing of sand sieves, there is a tendency for the various sizes of grains or particles to segregate and not remain uniformly distributed. The problem is, therefore, to devise some method of preparing a series of samples that will have absolutely the same size gradation. It is hoped that the investigation will yield some valuable results along this line and that progress in its solution can be reported in the near future.

Strengthening and Reconstructing Highway Bridges for Heavy Motor Truck Traffic*

It has been estimated that more than 50 per cent of the highway bridges are a distinct menace due to either of two things—original construction not strong enough for modern traffic demands, or deterioration.

Most of the states have passed laws limiting the weights of trucks, the maximum allowable weight, as a rule, being in the neighborhood of 28,000 lb. This limit is fixed more to determine the liability of truck drivers and public officials than as establishing a final limit for the weights of trucks. Whenever the economy of heavier trucks is established, which will be when better methods of constructing pavements and better materials and designs for tires, etc., are introduced, it is fair to presume that the legal limit will be raised.

Trucks considered now to be heavy may appear puny in 1975. The engineer, therefore, is using good economy in looking well into the future in designing new bridges. The cost of the additional strength is a comparatively small proportion of the total cost of the bridge, and is trifling compared with what it would cost to strengthen it when that becomes necessary, as it surely will before very many years. If, however, an old bridge is to be strengthened, it is only a makeshift at best and the engineer is not justified in looking many years ahead in deciding on the assumed loading.

In the course of an investigation by a committee of the New York Legislature, it developed that there were in that state about 33,800 public highway bridges more than 5 ft. in span, which would indicate that there are about 400,000 such bridges in the United States. It is safe to say that the failure of any one of a very large proportion of them would be liable to cause loss of life. It is also probable that more than 50 per cent are unable to carry a modern heavy truck with a reasonable margin of safety.

Points to Be Observed in Inspecting Bridges.—Every bridge should be inspected at least once a year by a competent man. A majority of the bridges consist of a single span of wooden stringers with plank floors. In the case of such bridges the main points to be observed are the safety of the abutments, the sufficiency of the width, the safety of the railing, the adequacy of the waterway and the strength and soundness of the stringers and planking. All these points require sound judgment and reasonable amount of engineering knowledge. With the larger bridges the responsibility is greater and the danger of loss of life in case of failure is also greater. Many bridges require inspection oftener than once a year.

All steel bridges should be painted every three or four years by competent men who are carefully instructed to report all defects observed. Many parts of steel bridges are not accessible for proper inspection without the use of scaffolding such as painters use. It is not always practicable to employ such scaffolding during the annual inspection.

In preparation for the advent of heavy trucks all public bridges should be examined by competent men who will make a record of the character of the traffic likely to come upon the bridge, the dimensions and conditions of all vital members and the sufficiency of the details, and written reports of such inspections forwarded to the proper state department for record. From these reports it must be decided which bridges require complete reconstruction, which require new superstructures, and which can be repaired and strengthened. The necessary plans can then be prepared and should be checked on the ground. Copies of all inspection reports should, of course, be filed with the proper local authorities, especially if they have charge of the bridges, but the state can better afford to employ competent men and records kept in the state capitol are less likely to be lost than those stored in local offices.

Thorough Examination Should Be Made of All Important Bridges.—The strengthening of old bridges often requires far more engineering skill and ability than the design and construction of new ones. The committee does not consider that in deciding whether any given member of a bridge needs strengthening, it is necessary to hold strictly to the letter of the standard specifications in the matter of unit stresses. In fact, a deficiency of 20 per cent in material is not serious, provided the details are good and the material is in good condition, it being felt that the usual unit stresses adopted make that much allowance for deterioration, besides secondary stresses, etc.; less allowance, however, should be made in the case of floorbeam hangers, stringers and floorbeams which are subject to widely and rapidly varying stresses. In considering the strength of a bridge truss it is not necessary to assume that the bridge is packed full of trucks of maximum weight, but if the bridge is 16 ft. wide or over, it is always possible that two heavy trucks may pass on the bridge.

The committee feels that, in cases where a bridge must be rebuilt or where the strengthening would make it, in effect, a permanent structure, it should be designed to carry a truck weighing at least 20 tons, with no allowance for impact.

The committee fully recognizes that the immediate strengthening of all bridges in the country that need it together with the reconstruction of those which cannot be economically strengthened is a physical as well as financial impossibility. It would, therefore, recommend that immediate steps be taken to have a thorough examination made of all important structures by competent engineers and their safe loads determined and indicated by proper signs to the end that the public be protected so far as is humanly possible. Any person who disregards these notices and suffers disaster has only himself to blame. The work of preparing plans for strengthening should then proceed without delay so that construction can be taken up as rapidly as possible.

How Old Bridges Can Be Strengthened.—The small bridges will generally have to be rebuilt, the steel truss bridges will generally be found fairly strong in the trusses but altogether too weak in the floor system. Many steel bridges have suffered seriously from neglect of painting and maintenance.

Very frequently the steel about a foot above the bridge floor is very badly corroded. In such cases tension members would have to be reinforced, which can generally be done if they are of structural shapes, but if the bridge is pin-connected, the bridge can be supported on falsework and new tension members inserted.

Corroded compression members can very often be effectually and permanently strengthened by concreting in the corroded parts. The concreting should extend beyond the corroded parts far enough to secure sufficient adhesion. Defective details will generally have to be corrected, even at considerable expense.

The attempt is sometimes made to strengthen a truss by placing another alongside it. If this is done great care must be taken that each truss carries its share of the load. The floor system should be supported on falsework and disconnected from both trusses, which swing free, and then connections should be made to both the old and new trusses. The upper bracing should be connected to the new trusses also to give them lateral stiffness. If the stringers only are somewhat weak their number can be increased at quite a moderate expense. If the stringers are very weak they should be replaced with new ones of sufficient strength. Weak floorbeams can generally be strengthened by riveting on new cover plates. The hangers should be carefully scrutinized for defects as well as for design, and if necessary, replaced with stronger ones.

Few of the steel truss bridges are strong enough to carry paved floors, although many can be refloored with 2x4-in. creosoted wood set on edge and spiked closely together. This will give a much more durable floor and one much less liable to break through under heavy loads. The weight is but little greater than that of a plank floor.

Plate girders can often be strengthened by riveting on additional cover plates. Riveted lattice trusses can often be reinforced to carry paved floors without throwing away any existing material. Pin-connected trusses can rarely be strengthened and occasions frequently arise where it is necessary to support the floor by means of timber bents, consisting of piles, if the bottom is soft; or by means of mud sills and posts, if the bottom is hard. If these are used they should be placed under all the floor beams, the outer posts being about 2 ft. inside the center lines of the trusses. This method, of course, is not suitable if the stream is likely to carry much drift wood or floating ice.

---

*From a progress report of the committee of the American Road Builders' Association, of which [illegible], engineer of bridges of the Pennsylvania State Highway Department is chairman.

Timber truss bridges can often be strengthened. If as is frequently the case, the floor only is weak, it is generally possible to put in heavier timber in the floor or to strengthen it with steel to carry heavy trucks.

Stone arches are almost always amply strong to carry the load if they are in good repair, but it is sometimes necessary to remove the earth covering and grout the joints between the stones to give them full bearing. Stone arches, moreover, will usually show signs of distress long before total failure.

It is rarely possible to strengthen a plain or reinforced concrete arch. If a truss is weak it seldom increases its strength to place bents under the floorbeams unless all the floorbeams are supported in the same way, taking the load almost entirely off the trusses. Plain concrete arches are more liable to fail suddenly without warning than almost any other kind of a bridge.

Steel truss bridges are nearly always fairly well designed except sometimes the details are weak; that is to say, if they are weak at all, they are correspondingly weak throughout. If it is desired to strengthen them as a whole, so as to carry a paved floor, it is almost always about as cheap to scrap the bridge and build a new one as to reinforce the old one. Besides, if the former is done a modern, well-designed bridge of ample strength will result. Otherwise the result will be an unsightly makeshift which will have to be repaired again in a few years.

If a bridge is at the foot of an incline, as is often the case, trucks are likely to cross them at a high rate of speed, which not only increases the stress, but also increases the danger to life and limb, to say nothing of property, in case the bridge fails.

The question of detouring traffic while a bridge is under repair, is often quite difficult. It is frequently possible to support the old bridge with bents and maintain traffic over the bridge during repairs, although this method adds considerably to the cost of repairs. Sometimes a timber trestle can be built alongside or in the vicinity.

If a bridge is to be replaced it is sometimes possible to move it bodily sidewise on temporary supports and construct new temporary approaches.

Methods of Carrying Out Strengthening Work.—As to how this work of strengthening should be carried out, much depends on circumstances. Estimates of cost are sometimes misleading. Unit costs of repair or alteration work in place are often more than twice the unit costs of similar material in new work. When an engineer starts to repair an old bridge he is almost certain to find a considerable amount of work that must be done that he had not anticipated. For these reasons it is usually best to have the material furnished or fabricated by contract and the field work done by days' work if a reasonably efficient gang can be organized. Expensive equipment such as pile-drivers, air-compressors, etc., may be rented on a per diem basis.

If it is a well-defined job such as replacing a floor system, or an abutment, it can be done satisfactorily by contract; otherwise a bidder is confronted by the same difficulty as the engineer in estimating his cost and will either bid high to cover risk and uncertainty, or will bid reasonable prices expecting to make up with his bill of extras, which will be no small item.

Another difficulty often encountered in a repair job handled by a lump-sum contract may be illustrated as follows: The engineer estimates $10,000 as an outside figure for the job, he secures an appropriation of $15,000 to cover extras; the bidders have no way to estimate accurately their cost and are apt to be guided by the amount of the appropriation and bid about $14,900, leaving far too small a margin for extras. If an efficient gang cannot be organized, the cost plus system is generally the best. One difficulty that must be considered is that of insuring that the work can be done within the appropriation.

The list of bridges which have failed under heavy trucks, with or without loss of life, is a long one. In the vast majority of cases it is only the planking or the stringers which have broken through.

The courts have decided that it is the duty of the driver of a vehicle to make sure of the safety of a bridge before he crosses it, a duty of which he is often incapable, it being frequently a highly technical matter. He will usually be guided by experience. If a bridge has been crossed by heavy loads it will be considered safe for the same load again. This may be true and may not, a structure that is overstrained will be weakened thereby although it may not fail immediately. "The last straw breaks the camel's back."

Considerations in Letting Contracts for Alteration Work.—In submitting alteration plans for bids, they should be made as complete as practicable and should guarantee all dimensions which the contractor cannot readily verify. Dimensions not guaranteed should be sufficiently accurate to enable the bidders to make close estimates of the quantities of materials required.

All requirements regarding maintenance of traffic, etc., should be clearly stated and if the work must be done at certain seasons of the year or certain days of the week or certain hours of the day the fact should be clearly stated.

All matters concerning the rights of way, encroachments, etc., which may lead to lawsuits should, of course, be handled by the local officials. Juries are much more generous to the local public than to out-of-town contractors or counties or states. Besides, a lawsuit is far more vexatious and expensive to a contractor than to the local public.

It is generally best for the public to assume all practicable risks; i. e., to eliminate the gambling element from contract work so far as possible. Every competent contractor adds to his bid an amount sufficient, in his judgment, to insure against all risks. It is usually best to give him every incentive to reduce the damage from flood and bad weather to its lowest limits. The contract should provide that the contractor should have an extension of time in case the work is necessarily delayed by bad weather, fire, flood or other accident. Similar provisions regarding delay due to strikes, delays in transportation, congestion of the material market, etc., should be contingent on the contractor having, in good faith, done the best he could under the circumstances. Prophetic wisdom should not be assumed to be an attribute of a contractor.

An excellent plan is to allow the contractor a certain number of working days to do the work, the time to be reckoned from the time he receives orders to start work. In that way, proper allowance can be made for bad weather, flood, etc. The principal difficulty in the case of steel work is that the material is fabricated under cover, independently of the weather, and is delivered on the site ready to erect, but there are frequently long delays in procuring the material and getting it fabricated. It would evidently be useless to order the contractor to start work on a job before his material had arrived on the site, and, on the other hand, the delay in obtaining and fabricating the material might be unwarranted. It would, therefore, be better, in this case, to allow a certain gross period for delivering the fabricated material and a certain number of working days for doing the work at the site. The former period would depend very much on the state of the material market and the facilities for fabricating which may be available at the time. This, in turn, would depend somewhat on the magnitude and character of the job. If heavy timber is required there is often a considerable premium demanded for delivery from stock; besides allowance must be made for more or less waste. In such cases, if haste is demanded, a sufficient premium must be allowed for prompt completion to make it an object for the contractor to obtain the required timber from stock. It may be difficult, however, to frame up a legal contract containing that provision. The courts object to paying bonuses on public contracts.

It is good policy to make a job as attractive as practicable to the bidder. A contractor is apt to bid high on a job he does not want very badly. A repair or alteration job is not generally very desirable on account of the large amount of supervision required and the frequent vexatious emergencies that arise, which combine to make the overhead cost all out of proportion to the amount of material used. Besides, such jobs require a higher grade of skill and intelligence in the workmen than ordinary pieces of work. A highly skilled workman is apt to get disgusted with that kind of a proposition. There is not infrequently much difficulty in finding a contractor who is willing to be bothered with a repair job. Often the best man is a small contractor who has nothing else to do, if such can be found.

If it is decided to rebuild the bridge, a proper investigation must first be made by a competent engineer to determine the required waterway and the type, span and width of bridge to be built. Frequently a new location is preferred; if not, the old masonry must be rebuilt or altered.

The question arises as to whether work should be paid for on a unit price or lump-sum basis. If proper facilities are available for accurately determining the quantities, the unit price method is usually the best, then if minor changes are found desirable as the work progresses nobody suffers any injustice. If the lump-sum plan is adopted, there is more certainty that the cost of the work will not exceed the appropriation, which is under many circumstances a very important matter. In contracts for bridge masonry there is generally considerable uncertainty as to the depth to which the foundation must be carried. This can only be determined as the excavation progresses. The contract should be so drawn that no injustice is done if the depth of the foundation is much greater or less than shown on the plan. All plans for lump-sum work must, of course, show full details.

It behooves the more intelligent citizens, as well as the engineering profession, who realize the necessity of a reasonable margin of safety, to convince the press and the general public of this necessity to the end that liberal appropriations may be made for the purpose of making proper inspections, repairs, alterations and reconstructions and also of the fact that much of this work is highly technical and must be placed in the hands of experts.

If the number and importance of the bridges involved is sufficient to justify it, a competent man or men should be employed at adequate salaries to make inspections and repairs. Such men will make proper studies of traffic conditions and the peculiar dangers and conditions of each particular structure and act accordingly. They will take care of the most dangerous bridges first and, as funds are generally quite limited, will see that the available funds are made to go as far as possible and that no work is undertaken for which there is not an adequate appropriation.

If the number of bridges is too small to justify the employment of a salaried engineer, one who is not connected with any concern engaged in constructing or furnishing material for bridges, should be employed on a per diem basis.

It is the duty of officials in charge of public highways to maintain them in such condition that they are safe and convenient for all reasonable and lawful traffic which may come upon them; and the limit of loading on bridges of a state should be fixed by statute in order to determine what are reasonable and lawful loads. It being understood, always, that any private parties desiring to transport heavier loads on them than is provided for by statute, can do so by paying the extra cost of making the bridges of the desired strength.

Water Proofing Blue Prints and Drawings

A simple method of waterproofing drawings, blue prints, etc., described by Mr. F. A. McLean, in the Oct. 14 issue of the American Machinist, consists in saturating the prints with "parawax," a melted parafine wax such as is used for sealing fruit jars. Mr. McLean states that if the prints are placed directly into a pan filled with this molten wax they will soak up too much of it and will always feel more or less greasy to the touch. The most convenient way, therefore, is to soak a number of pieces of absorbent cotton cloth a foot or more square in the wax. When these pieces of cloth are cool lay as many as are required (depending on the size of the blueprint) on a table or other smooth surface, place the print on top of these and then on top of the print lay more of the cloths until it is entirely covered. After this is done it is only necessary to run a hot iron over them for a few moments. The print will immediately absorb the paraffine until the surface becomes saturated. If the table on which the work is carried out has a highly finished surface a layer or two of heavy wrapping paper should be placed between the cloths and the table. Should one of the family irons be used in the process it would be a good plan to interpose a piece of wrapping paper between the iron and the cloth, as it will prevent the iron from being fouled with the wax.

Handling Bulk Cement on Large Building Job

A saving of time and money was effected in constructing three 8-story buildings at St. Louis, Mo., for the United Drug Co., by using bulk cement. The job required 80,000 bbl. of cement. The methods of handling this are described by Mr. W. A. Dame, Superintendent for the Westlake Construction Co., the contractors, in the September Contractor's Atlas, from which the matter following is taken.

The bins for storing concrete material are shown in Fig. 1. At the left are the sand bins. In the center, occupying about double the space, are the gravel bins and at the right is the bulk cement bin which has a ground area of 18 ft. by 36 ft.

The materials come in open top cars and are conveyed direct into the storage bins by means of a clam shell bucket. The bins are of sufficient size so that only a very small reserve stock pile need be used, the location of which is shown in the drawing Fig. 2.

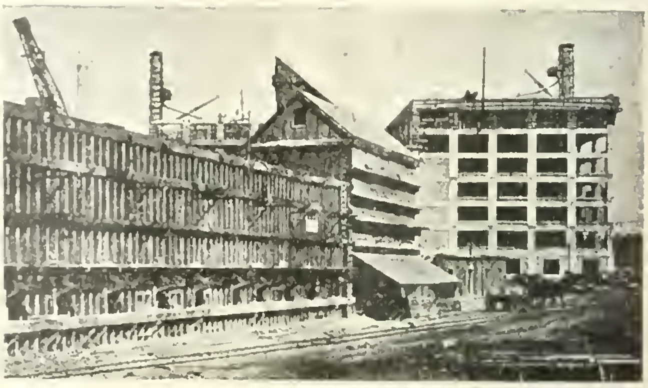


Fig. 1.—Cement, Sand and Stone Bins.

The cement bin is supported on 12x12 timber posts spaced 6 ft. on centers with steel tie rods at about 4 ft. intervals, through the upper part of the structure. The floor has a 45° slope in one direction and is made of matched flooring over ship-lap. A thickness of building paper between these prevents the dust coming through and the penetration of moisture from the outside. 4x12 joists, 16 in. apart, were used to support the floor. The construction throughout is probably somewhat heavier than is actually required.

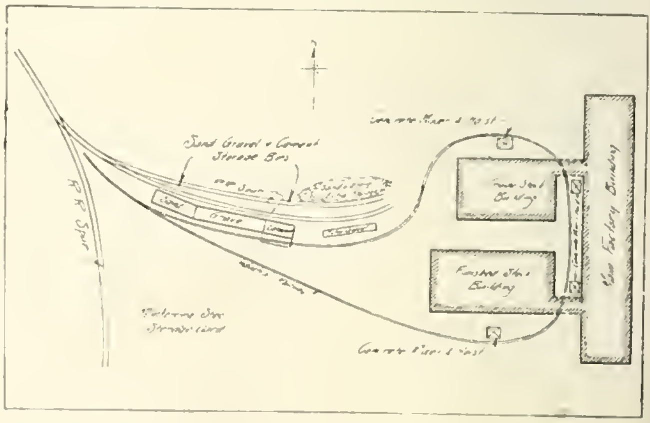


Fig. 2.—General Layout of Concreting Plant.

In unloading the cement two power scoops pulled the cement to the center of the car and into a "boot" from which an ordinary bucket elevator elevates it into the bin. The labor was not heavy and so far as the dust was concerned, the men who actually did the work said they would rather unload cement in bulk than in sacks. In fact, throughout the entire job, there was a regular rejoicing among the men when the cars of bulk cement came in to be unloaded.

All the materials for the concrete work could be dumped direct into cars of the industrial railway in surprisingly quick time. Two men handling the gates can put the right amount of sand and gravel into a 6-car train in very short time, the sand being deposited first up to a line of rivets in the car. The gravel follows up to a second line of rivets and the train is pulled forward into the cement shed.

There are four outlets from the cement bin consisting of knife gates acting vertically. Cement is run from these gates into measuring boxes, each containing 1 cu. ft. These are readily pushed by hand down a slightly inclined angle iron trolley and are unloaded on top of the sand and gravel in the cars by the simple pulling out of the knife gate in the bottom of each box. Two men can fill and empty the four boxes without delaying the train and with remarkably little loss of cement. A canvas skirting around the bottom of the box prevents the dust from flying.

When the stock of cement ran low in the bins, it was necessary to have men hoe it toward the outlets. This might have been avoided had a hopper bottomed floor been built. When there was a reasonable stock of cement in the bins, however, there was no trouble on this account. The system worked nicely and the measuring boxes gave an exact check on the amount of cement being used.

Two small gasoline engines drew the trains of cars each loaded with proper amounts of sand, stone and cement, around the job and dumped the materials direct into the hopper of the mixer. Four mixers were used on the work, a general layout of which is shown in Fig. 2.

The engine pulling the cars would drop off two or three at each of the mixers and push the empties back to be reloaded. As fast as the mixer turned out the concrete, a car was pushed a few feet forward by hand and tipped over into the hopper for a new charge. The mixers were placed below grade and, together with a boiler which operated them and the hoist were all housed in. At each mixer was a hoist tower which gave us good distribution.

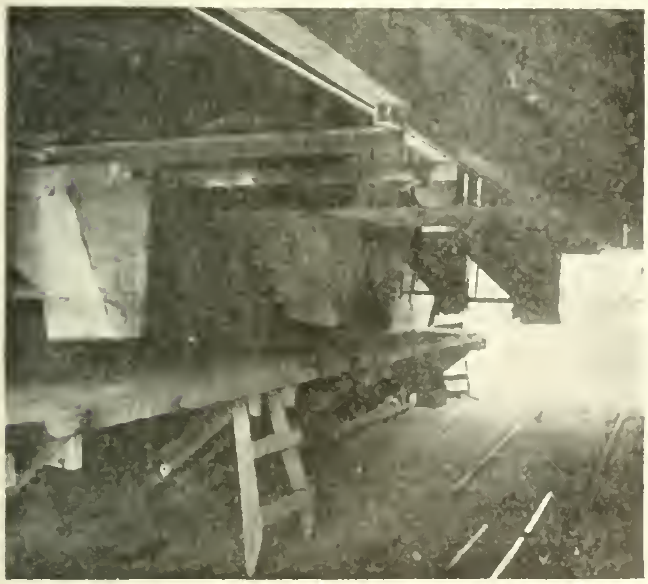


Fig. 3.—Steel Cement Measuring Boxes Running on Overhead Tracks.

To provide against emergencies an extra storage of sacked cement was kept on hand, together with piles of sand and gravel dumped along the railroad. Several times good use was made of these emergency stocks.

The installation has given very good satisfaction and it has cost only about 3½ ct. a barrel to unload cement in bulk. In addition to saving time, the saving in cost in the handling of cement has been considerably more than we anticipated.

New Workmen's Safety Plan in Building Construction.—In the erection of large extensions to the plant of the American Rolling Mill Co. at Middletown, O., the contractors, the Dwight P. Robinson & Co., are using a new method for enhancing the safety of the workmen engaged on this project. At 2 p. m. each Tuesday a committee composed of foremen, mechanics and laborers inspects the entire job from sewers to roof with the one purpose of seeing that proper methods are taken to safeguard the employes against accident. This committee makes a detailed report of each inspection to a representative safety committee, which considers and puts into effect the recommendations of the inspection committee.

An Engineer's View of the Labor Problem*

By CALVERT TOWNLEY

President American Institute of Electrical Engineers

One of the most important problems which the American people now have to solve is that of the relations between the employer and the employe classes, generally referred to as capital and labor. A large measure of our national success will depend upon this solution, and as engineers are even more directly affected by and therefore more intimately connected with, industrial prosperity than are the other professions, it is more obviously their duty to assist in the solution of the problem as much as they can.

Relations Between Capital and Labor from Engineering Standpoint. Although this subject has been voluminously discussed by numberless people, there is one angle from which, so far as I know, it has not been treated, namely, from the standpoint of what is instead of what ought to be, that is to say, from the engineering standpoint, one of fact, human nature and of economic laws as contrasted with the laws enacted by man.

To begin with, the first law of Nature is self-preservation. It is manifested in its highest form as patriotism, in its lowest as sordid greed. Between these two extremes appear all forms of selfishness, many of them by no means blameworthy, others under control or not infrequently dormant, but nevertheless certain to manifest themselves when circumstances compel.

For example, selfishness is the actuating motive in barter. It leads the seller to try to sell at the highest price and the buyer to try to buy at the lowest. Barter and trade are at the foundation of industry and, having been always recognized as essential to prosperity, have been encouraged and protected. The ideal condition for barter is where both parties are absolutely free agents and neither therefore under duress.

Too great power, if continued long enough, will always be abused, and just as such power in government becomes tyranny, similarly, too great advantage in barter begets commercial robbery. These statements sound like platitudes, and I should hesitate to repeat them were it not for the fact that they not only bear directly on the present situation between labor, capital and the public but seem to be so frequently forgotten or ignored.

The One-Sided Conract of Union.—In the time-honored barter between employer and employe the employer formerly held the strategic position. As business concerns grew larger, this advantage naturally increased and just as naturally the employers' power was abused. By and by the resulting oppression became sufficiently acute to provoke general resistance, and the labor union came into being.

Workmen banded together to eliminate competition among themselves. The effect was generally beneficial because it corrected an evil, and the general public, while not particularly interested, looked on approvingly. But early in their history the unions made a serious although not a surprising blunder. They set up a system of contracts between employer and employe and, because they could escape doing so, provided no means by which the workmen could be penalized for violation, except by the union itself.

This flagrant flouting of a fundamental did not for a time have any serious effect, but the blunder once made was never thereafter corrected and it is probable that even today it would be difficult to find a labor leader who could be made to see the seriousness of this mistake, much less to endeavor to rectify it.

The World War created an entirely new condition—an imperative demand for men came up almost over night. The effect on the price of labor was axiomatic—it rose. The unions, being the vehicles through which the demands of many classes of workmen could most readily be expressed, at once became active. Wages and prices rose to hitherto unheard of figures. Labor had too much power; their demands had to be met whether or no, and of course they abused their power.

The Unions Became the Oppressors.—Then the unions made another mistake. They credited too much of their successes to their organization and failed to appreciate the part played by the law of supply and demand. Also they underestimated the power of resistance which would be engendered by oppression. In their turn they became the oppressors—insistant—arrogant. Where their principal weapon—the strike—was not effective as against the employer class in one industry, they enlisted the workmen in other industries and who had no grievance, in sympathetic strikes.

---

*Abstract of an address delivered June 29 at Annual Convention of the American Institute of Electrical Engineers, White Sulphur Springs, W. Va.

We hear that a new order of things has come to pass; that the "rights" of labor must now be respected; that the workman will hereafter have a greater share of the products of his toil; that he must share in the management of industry and have a recognized place in government and the like. To my mind the facts warrant none of these assumptions.

There is no new order—economic laws are the same as they have always been. They are as ruthless and as inexorable as are the laws of physics. Neither has human nature changed. The unions are in the saddle but, to use a hunting expression, they are riding for a fall. Please let me remind you again that I am not blaming the unions—or anyone else. I am trying to confine myself to statements of fact and to logical opinions based thereon according to the precept and training of the engineer.

The individual workman cares no more for his fellow as a class than does the employer. It follows therefore that a union must continue to succeed or it will disintegrate and disappear. The history of the last 30 years has recorded many once powerful unions even the names of which are now almost forgotten. The "Knights of Labor" and "The Amalgamated Associations of Iron and Steel Workers" are two examples which illustrate the point.

The strength of organization contending against the mob is very great, and it is probably true that so small a portion as 10 per cent or even five would prevail under these conditions. That, in fact, is the situation confronting the nation today. This small organized percentage, supported by the operation of the law of supply and demand, has prevailed, but looking into the future it seems clear that there is only needed a sufficient incentive to induce the unorganized 95 per cent or even a small part of them, to get together in opposition to the 5 per cent in order that the latter may be overwhelmed.

This incentive has been or will be furnished by union oppression. I say "has been or will be" because the abuse of too great power always grows. Therefore if the unions shall still continue to gain their ends even in the face of their present insolence and ruthless disregard of others, their arrogance and self-confidence born of such success, will inevitably lead them on to acts of greater and yet greater oppression until they force their opponents to combine against them for defense or even for self-preservation.

Indications That Union Domination is About Over.—Already there are indications that the people will not much longer submit to domination by the unions. The governor of Massachusetts defied them, was shortly thereafter reelected by an abnormally large majority and has now been nominated on the Republican National ticket for Vice-President, which latter distinction it is safe to say he owes almost entirely to this incident. The state of Kansas has enacted a law to curb union interference with the peace and comfort of her citizens, and her governor has become a popular national figure in consequence.

The temper of much of the daily press has changed, and where formerly there was much said about the so-called "living wage" and criticism of "capitalistic greed," there now appear articles about "the vicious cycle of mounting wages and costs," "loafing on the job" and the "need to teach the people thrift and economy." Whether or not an aroused public does curb union domination, the present high wage era will not be radically affected. That is a condition controlled not by the unions at all, but by the much discussed law of supply and demand.

Lest I may be misunderstood, I might here state that because I have been confining myself to a discussion of the relations between the employer and the employe and have had much to say about the employe's abnormally high wages, I do not want to be understood as giving that condition as the only cause of the prevailing high prices.

Advantage has very generally been taken of the opportunity to increase profits by those who had wares to market, which is only another way of saying again that selfishness is a universal trait of which no class or classes have a monopoly. Government reports of falling exports indicate that the expected lessening of the foreign market for our high-priced products is approaching, and it is not at all unlikely that this may be followed by heavy increases in our imports which will displace American-made goods.

This result may come about both because foreign nations are getting into their stride of production again and because the high prices prevailing here have naturally created an attractive market. A combination of these and other conditions will reduce the demand for our products and consequently for the workmen to produce them.

The immigration authorities of the Port of New York report their facilities overtaxed to handle the large numbers coming to our shores and say that even those numbers would be far larger if there were only more ships to carry the people who want to come. It is natural to suppose that as the heavy burdens of after-war taxation are brought home to the foreign people, an increasing percentage will seek to escape them by coming here to live and also that the gradual restoration of transatlantic shipping to its normal schedules will afford the greater facilities thus demanded. This augmentation of population—largely workmen of course—will swell our supply and likewise tend to correct any shortage that may exist.

No Material Permanent Change in Social Order to Be Expected.—If any analysis of the facts is correct it is clear that the present domination by organized labor is temporary and also that the era of high prices will pass. Therefore, no material permanent change in either our social order or in our industrial structure is to be anticipated. In the contest between brains and brawn, waged since the world began, brains have always won and brains always will. Free play for the natural forces of trade may be counted upon to exercise a beneficial influence, and they should be hampered and interfered with by government restrictions as little as possible.

We cannot, of course, determine from history or from any fact at hand, how long a time it will take for conditions to become normal again, but what we need now is clear thinking, courage and patience. I know that we can rely on the engineer, for clear thinking, and I haven't the slightest doubt about his courage, but I am not so sure about his patience. You should be leaders of thought in your several circles. You can help to allay much of the present anxiety about the so-called unrest and the apprehension as to the future, therefore, I feel warranted in asking you to give your close consideration to the subject matter of what I have said this morning.

Removing Reinforced Concrete Balconies by Air Drills and Oxy-Acetylene Gas

Reinforced concrete balconies of the cantilever type consisting of nine boxes each at the Harlem Casino, New York City, were removed by drilling to separate the concrete and cutting the steel reinforcing with oxy-acetyline gas. The method is described in Concrete.

With compressed air drills the slab was separated from the supporting cantilever girders and the adjoining girders on the face of the balcony level. The cantilevers were then cut at the supporting columns by the same method. Two holes were cut in the mid-portion of the slab and the entire slab was lowered with a breast derrick to the reinforced concrete floor below and then taken away by means of rollers and disposed of en masse.

The oxy-acetylene gas was used to cut all reinforcing steel. In doing this gas cutting it was found that the concrete, where the flame came in contact with it, disintegrated, sending off a shower of sparks. It was evident that the concrete could have been cut with oxy-acetylene gas if the men had been provided with helmets and other protection sufficient to prevent the flying sparks from burning them. But as this protection was not available and for the amount of work involved the expense would have been too great to provide it besides the time lost in getting the protection, it was not attempted to cut the concrete by the flame method.

Four air drills were used on each slab and progress was made at the rate of one slab, including cantilever girder, every two hours. No difficulties were encountered in the process of the work and the method used proved very satisfactory.

The work was done by John B. Roberts & Co., 3 W. 29th St., New York City, under direction of L. C. Roberts, Engineer.

A New Machine for Measuring the Bearing Value of Soils

The progress report* of the special committee to codify present practice on the bearing value of soils for foundations, to the American Society of Civil Engineers, contains a description of a field testing apparatus that seems to be of a very practical nature. In designing this apparatus the following points have been kept in mind

First, a capacity great enough to give a curve extending beyond the limit of safe pressure for ordinary soil or, say, 10 tons per square foot.

Second, a degree of sensitiveness such as to give a compression diagram for soils of very light bearing capacity.

Third, a machine requiring for its construction only ordinary labor and materials available on most construction jobs.

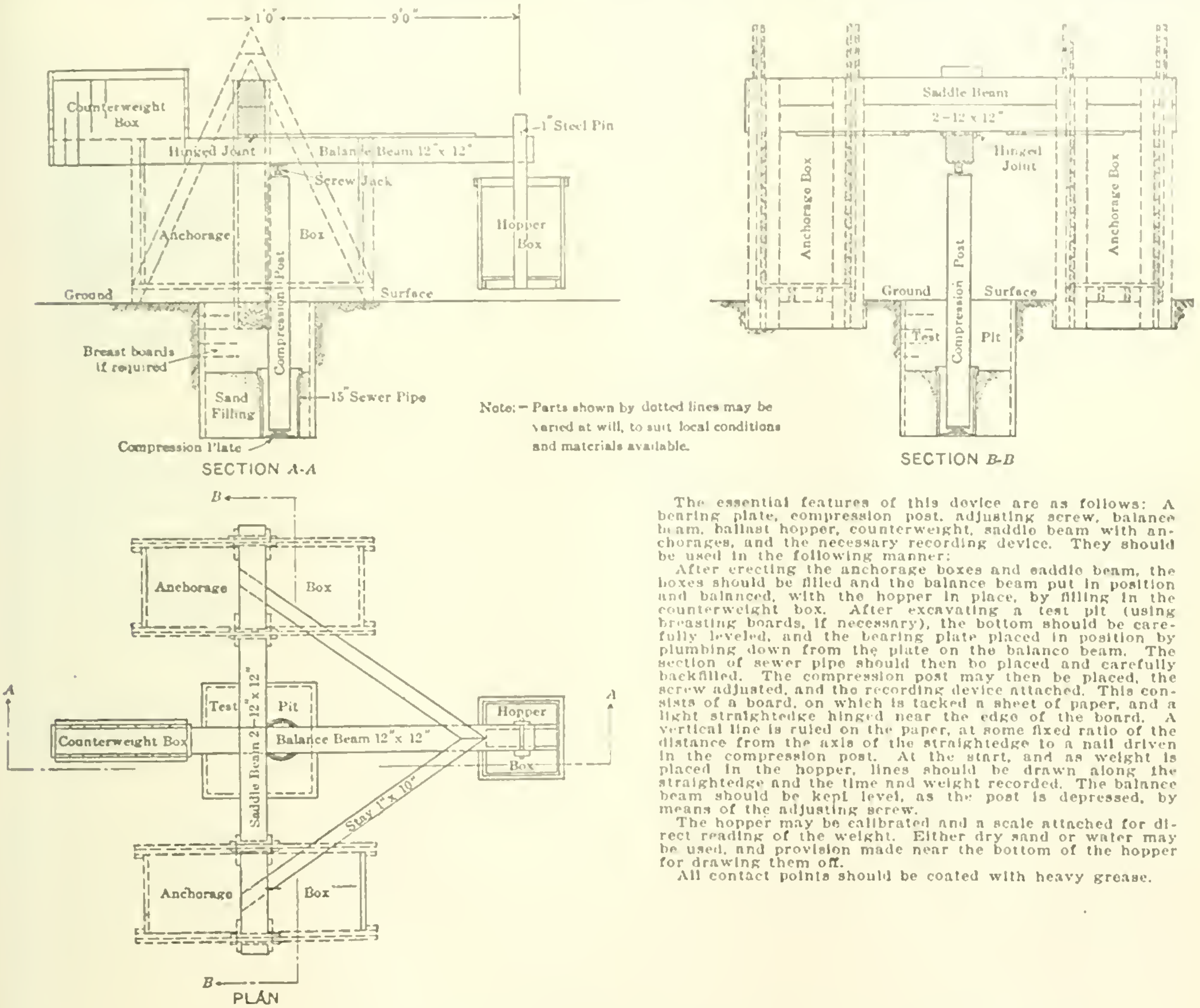
Fourth, a machine requiring for the weight to produce compression or pressure only materials such as earth or water, available in any locality where construction is likely to be in progress.

These imposed conditions at once limit the type of machine, and bring the construction within ordinary carpentry or masonry, or a combination of the two, and limit the substances to be used in producing compression to two, either water or earth.

After considerable thought, the committee proposes a machine in the form of a balanced scale, built principally of timber. Its capacity is limited to about 10 tons, which is sufficient to cover all cases of ordinary soils, and give a compression diagram exceeding the safe load. In the event that soils of greater or lesser bearing value are encountered, it would be necessary to substitute other bearing plates under the compression post, of smaller or larger areas. With the exception of the bearing plates and the screw at the top of the post for taking up compression, all materials can be shaped and placed in the field, and even these could be prepared in form sufficiently accurate for the purpose, if there is on the work a blacksmith shop and screw cutting device.

For measuring the amount of compression of the soil, the committee suggests, as shown in Fig 1, a mechanical device, very simple in character, which is preferable to the use of a wire and scale. The use of wire and scale requires that it be constantly watched, and that visual readings of the scale be taken at frequent intervals The high resistance of most soils makes the reading of the smaller penetrations at different pressures rather uncertain, and a better curve of compression could be obtained by the method suggested. It consists simply of a board, on which is tacked a sheet of paper, with a straight-edge of thin material fastened at a certain fixed distance from a nail on the compression post, against the upper edge of the straight-edge. By drawing a vertical line on the paper, at a definite multiple of the distance between the hinge and nail in the post, a multiplied diagram of the compression for different loads is obtained, reading from a zero line drawn on the paper across the straight-edge before starting the test. At various pressures and compressions, similar lines can be drawn and the time and load noted on the paper, and the actual compression reduced by the ratio of the two distances. By this means a more accurate compression diagram can be made.

Attention is called to the fact that this machine has practically only one moving part, viz., the vertical post causing the compression of the soil. So long as this post maintains a purely vertical position, it is uninfluenced by any distor-



SECTION *A-A*

Note: — Parts shown by dotted lines may be varied at will, to suit local conditions and materials available.

SECTION *B-B*

PLAN

Fig. 1—Essential Features of Proposed Standard Large Type of Load Testing Apparatus for Soils.

The essential features of this device are as follows: A bearing plate, compression post, adjusting screw, balance beam, ballast hopper, counterweight, saddle beam with anchorages, and the necessary recording device. They should be used in the following manner:

After erecting the anchorage boxes and saddle beam, the boxes should be filled and the balance beam put in position and balanced, with the hopper in place, by filling in the counterweight box. After excavating a test pit (using breasting boards, if necessary), the bottom should be carefully leveled, and the bearing plate placed in position by plumbing down from the plate on the balance beam. The section of sewer pipe should then be placed and carefully backfilled. The compression post may then be placed, the screw adjusted, and the recording device attached. This consists of a board, on which is tacked a sheet of paper, and a light straightedge hinged near the edge of the board. A vertical line is ruled on the paper, at some fixed ratio of the distance from the axis of the straightedge to a nail driven in the compression post. At the start, and as weight is placed in the hopper, lines should be drawn along the straightedge and the time and weight recorded. The balance beam should be kept level, as the post is depressed, by means of the adjusting screw.

The hopper may be calibrated and a scale attached for direct reading of the weight. Either dry sand or water may be used, and provision made near the bottom of the hopper for drawing them off.

All contact points should be coated with heavy grease.

---

*Proceedings Am. Soc. C. E., August, 192

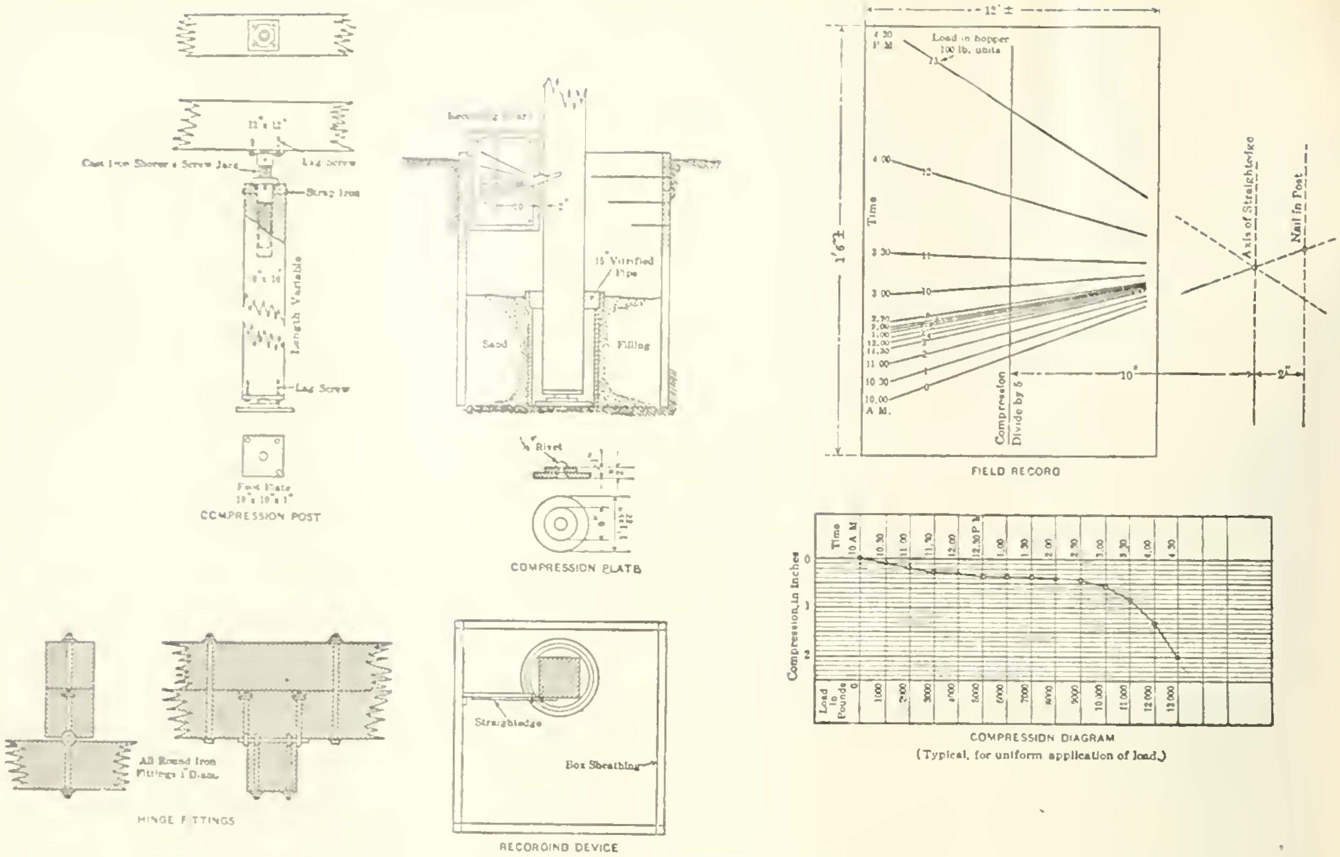


Fig. 2—Details of Proposed Standard Large Type of Load Testing Apparatus for Soils.

tion of any other part of the machine. From the behavior of timber and soil under such conditions, the committee is inclined to believe there will be no difficulty in maintaining the post in a vertical position. It should be borne in mind that this is intended to be a practical field testing machine and no great degree of accuracy should be expected. However, such a machine will take compression tests of soil with a considerable degree of accuracy.

Photographic Method for Showing Construction Progress

A photographic method that can be used for showing progress in certain types of engineering work, is described by Mr. M. H. Stillman, Assistant Physicist, U. S. Bureau of Standards, in Scientific Paper No. 392, under the title "A Scientific Method of Detecting Changes in a Complicated Group of Objects." The method was devised by Mr. Stillman, and developed for use in military operations.

The method may be described as follows: A negative is made of the group of objects in which a change is expected. After the change is supposed to have occurred a second negative is made with the same camera (or one of the same kind) on a plate of the same kind and from as nearly as possible the same position as used in making the first negative. A positive is printed from one of the negatives, is superposed upon the other negative so as to bring them into register, and the combination is viewed against a source of light. When the photographs are properly made, those parts of the combination which correspond to the unchanged portion of the group of objects will appear as a field of practically uniform density, while a change in the group will be revealed by a considerable departure from this uniform density.

In exposing for the negatives it is desirable that the camera be, as nearly as possible, in the same position for both exposures. This is especially important when both near and distant objects are included in the picture. When all parts of the picture are in sensibly the same plane, as when a photograph is taken from high in the air, the position of exposure may vary considerably and good results still be obtained.

If the two negatives are made from the same general direction but at different distances from the object, one of these may be enlarged or reduced as necessary, or it may be projected at the proper size onto a ground-class screen and its image matched there with the positive, or vice versa. When the negative and positive are not of the same size, it will of course be impossible to bring them into exact register, but if they are of nearly the same size it will be found that by shifting them slightly with respect to each other one portion after another will approximately register, permitting the entire picture to be examined by sections.

The light conditions at the time of making the two exposures should be as nearly as possible the same as regards position of source of light, intensity, and quality. It is evident, for example, that if one picture of a landscape were taken in the morning and another in the afternoon the changed position of the shadows would show up so prominently in the result that the changes sought might be overlooked.

In certain types of engineering work progress can be very well shown by an application of this method. For example, in the case of a bridge or other framework under construction provision is easily made for taking a photograph from the same position at frequent intervals of time. Then by superposing the proper positive and negative the progress in any period would be revealed, without painstaking comparisons.

Changes in complicated documents, drawings, and engravings are brought out clearly by this method. This suggests its application to the verification of the copies of engravings, drawings, and the like.

While the best results can undoubtedly be secured by a skilled operator giving attention to all the factors discussed herein, yet the method can be used successfully in many instances by those having only a very limited knowledge of photography and by the use of comparatively inexpensive apparatus.

Trade Publications Wanted.—Valparaiso University has recently reopened a complete course in Architecture Engineering. Trade publications applicable to this course will be gladly received and will become part of a file used to give the student first hand information of various building materials. Those publications giving manufacturers' specifications and methods of application will be especially welcome. Wilson Carleton is Professor in charge of department, Valparaiso, Ind.

Molybdenum Steels*

By G. W. SARGENT,

President Molybdenum Corporation of America, Pittsburgh

The manufacture of the alloy steels containing molybdenum is no more difficult than the same without the molybdenum. In fact, general experience indicates that the molybdenum increases the yield from ingot to shipped bars with less losses due to seams, pipeage and discards. These steels may be melted in the crucible, basic, or acid open-hearth and I believe, should be desirable, in the Bessemer converter.

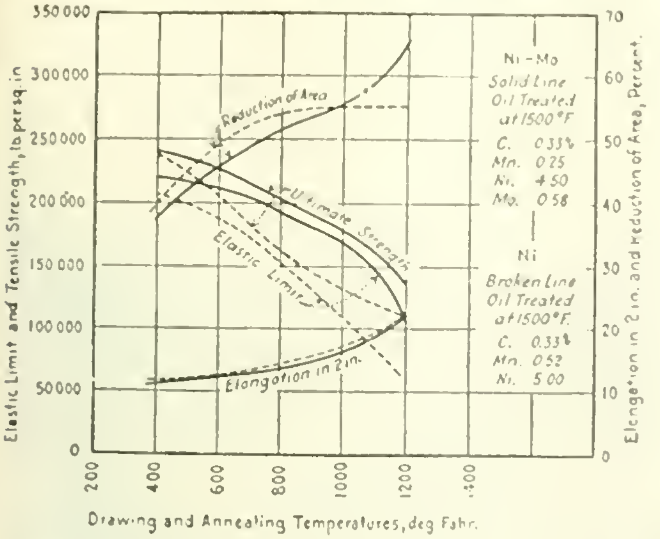


Fig. 1.—Comparison of Nickel-Molybdenum and Nickel Steels; 1⅛ in Round Bars, Heat Treated in Full Size, Then Machined to 0.505 in. Diameter.

The types of these steels developed for structural purposes are given in Table I.

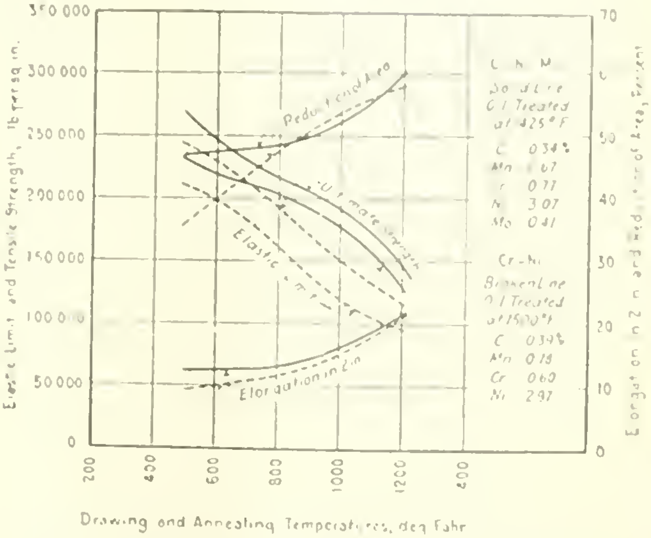
The physical properties of these molybdenum steels can readily be appreciated from a study of Figs. 1 to 3, inclusive.

In all these figures, it will be observed in the case of the molybdenum steels, that as the drawing temperatures are raised up to 1,000 to 1,200 F. to further increase the toughness, the decrease in tensile strength and elastic limit value is less than is the case with the other steels compared. Furthermore, reduction of area, which are the best measure of the toughness of the alloy steels, are generally greater.

The molybdenum steels as a whole in the rolled or forged conditions show uniformly higher tensile strength and elastic limits with greater elongation and reduction of area:

TABLE I—TYPES OF MOLYBDENUM STRUCTURAL STEELS

	No. 1 Per cent.	No. 2. Per cent.	No. 3. Per cent.
	CARBON-MOLYBDENUM.		
Carbon	0.10 to 0.50	0.10 to 0.50	0.10 to 0.50
Mn.	0.50 to 0.80	0.50 to 0.80	0.50 to 0.80
Phos.	not over 0.04	not over 0.04	not over 0.04
Sul.	not over 0.05	not over 0.05	not over 0.05
Mo.	0.25 to 0.50	0.50 to 0.75	0.75 to 1.00
	CHROME-MOLYBDENUM		
Carbon	0.10 to 0.50		
Mn.	0.50 to 0.80		
Phos.	not over 0.04	Same as the carbon-molybdenum but with 0.80 to 1 per cent chromium added.	
Sul.	not over 0.05		
Chr.	0.80 to 1.00		
Mo.	0.25 to 0.50		
	NICKEL-MOLYBDENUM.		
Carbon	0.10 to 0.40	0.10 to 0.30	0.10 to 0.30
Mn.	0.50 to 0.80	0.30 to 0.60	0.30 to 0.60
Phos.	not over 0.04	not over 0.04	not over 0.04
Sul.	not over 0.05	not over 0.05	not over 0.05
Ni.	1.00 to 1.50	1.00 to 1.50	1.00 to 1.50
or Ni.	1.50 to 2.00	1.50 to 2.00	1.50 to 2.00
or Ni.	2.00 to 3.00	....	....
Mo.	0.25 to 0.50	0.50 to 0.75	0.75 to 1.00
	CHROME-NICKEL-MOLYBDENUM.		
Carbon	0.10 to 0.40	0.10 to 0.40	0.10 to 0.40
Mn.	0.45 to 0.75	0.45 to 0.75	0.45 to 0.75
Phos.	not over 0.04	not over 0.04	not over 0.04
Sul	not over 0.05	not over 0.05	not over 0.05
Chr.	0.45 to 0.65	0.45 to 0.65	0.45 to 0.65
or Chr.	0.80 to 1.00	0.80 to 1.00	....
Ni.	1.00 to 1.50	1.00 to 1.50	1.00 to 1.50
or Ni.	1.50 to 2.00	1.50 to 2.00	.
Mo.	0.25 to 0.50	0.50 to 0.75	0.75 to 1.00
	CHROME-MOLYBDENUM-VANADIUM.		
Carbon	0.10 to 0.55		
Mn.	0.50 to 0.80		
Phos	not over 0.04	Same as chrome-molybdenum, but with 0.15 per cent vanadium added.	
Sul	not over 0.05		
Chr	0.80 to 1.00		
Mo	0.25 to 0.50		
Va.	0.15		
	MANGANESE-MOLYBDENUM		
Carbon	0.10 to 0.55	0.10 to 0.55	0.10 to 0.55
Mn.	1.20 to 1.40	1.20 to 1.40	1.20 to 1.40
Phos.	not over 0.04	not over 0.04	not over 0.04
Sul	not over 0.05	not over 0.05	not over 0.05
Mo	0.25 to 0.50	0.50 to 0.75	0.75 to 1.00
	SILICO-MANGANESE-MOLYBDENUM		
Carbon	0.10 to 0.55	Balance of analysis same as No. 1	Balance of analysis same as No. 1
Mn.	0.45 to 0.75		
Phos.	not over 0.04		
Sul.	not over 0.05		
Si.	1.75 to 2.00		
Mo.	0.25 to 0.50	0.50 to 0.75	0.75 to 1.00



Drawing and Annealing Temperatures, deg Fahr

Fig. 2—Comparison of Chrome-Nickel-Molybdenum and Chrome-Nickel Steels; 1⅛ in. Round Bars, Heat Treated in Full Size, Then Machined to 0.505 in. Diameter.

	Tensile strength, lb. per sq. in.	Elastic limit, lb. per sq. in.	Elongation in 2 in., per cent.	Reduction of area, per cent
No. 1 chromo-molybdenum as rolled, 1 in. round	140,000	105,000	15.0	32.0
No. 2 nickel-molybdenum as rolled, 1 in. round	120,000	93,000	18.0	39.0

ANALYSIS.

	Carbon.	Chromium.	Nickel.	Molybdenum.
No. 1	0.40	1.00	...	0.35
No. 2	0.40	...	1.50	0.40

The higher elastic limit of No. 1 as rolled, together with its easy machining qualities (for it machines as readily as the 70,000-lb. per square inch elastic limit managnese steel used for gun barrels), recommends it for the purpose.

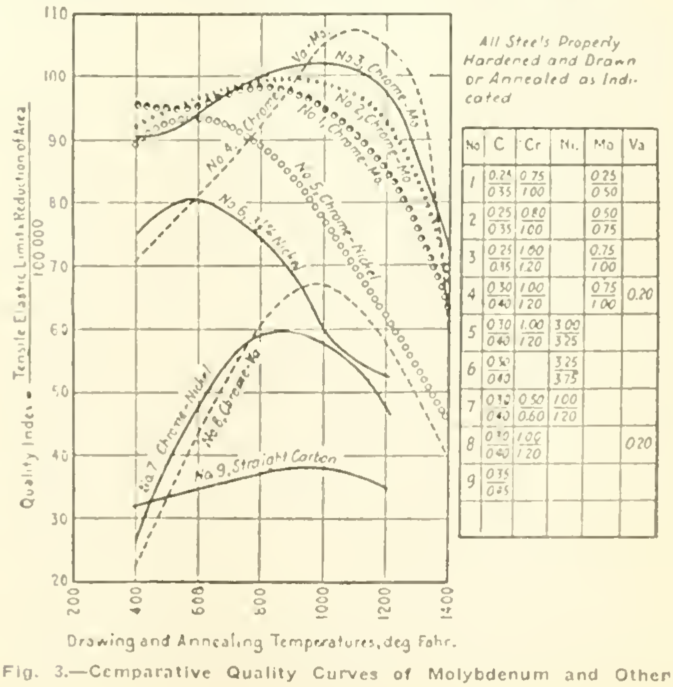


Fig. 3.—Comparative Quality Curves of Molybdenum and Other Alloy Steels.

---

*Abstract of a paper presented June [illegible] at the annual meeting of the American Society for Testing Materials.

The effect of various quenching temperatures on the tension test values of the chrome molybdenum steels is shown by the following table:

Quenching temperatures	Tensile strength, lb. per sq. in.	Elastic limit, lb. per sq. in.	Elongation in 2 in., per cent.	Reduction of area, per cent.
1550° F.	160,125	156,625	18.0	62.2
1600° F.	175,850	119,925	17.5	60.2
1650° F.	156,375	145,775	17.0	60.2
1700° F.	153,450	141,570	17.0	60.1
1750° F.	151,259	142,500	18.0	60.0
1800° F.	151,000	141,000	[illegible]	59.0

Drawing temperature: 1000° F. Quenching medium: Water. Three-quarter in. round bar. Analysis: 0.25 per cent carbon, 0.70 per cent chromium, 0.35 per cent molybdenum.

A microscopic study of the structure of nearly all of these steels shows great similarity in that, when quenched and drawn from 350 to 1,100° F., they show a fine uniform distribution of the constituents; so much so that the structure of the specimen drawn at 1,100° F. which presumably contains ferrite and pearlite, cannot be distinguished from that drawn at 350° F. except in the case of the lower molybdenum-content steels, which show, when drawn as high as 700° F., a martensitic or pseudo-martensitic structure. Otherwise even these are alike as the following studies show. When heated after quenching to 1,400° F., the ferrite separates out distinctly from the pearlite, which latter takes a more pearlitic structure. In other words, the steel becomes annealed.

From the steel maker's point of view, the production of these steels is commercially practicable. Now that the supply of molybdenum ore in large quantities is assured, these steels will be widely used. They cost less per pound of alloy used in their production than 3.50 per cent nickel steel. For example, the nickel in a pound of 3.50 per cent nickel steel at 40 ct. per pound costs 1.4 ct.; in 1.00 per cent chromium, 0.25 to 0.50 per cent molybdenum (0.40 per cent added) steel, with chromium at 20 ct. per pound and the molybdenum at $2 per pound, the alloys cost but 0.33 ct. for the chromium and 0.8 ct. for molybdenum, a total of 1.13 ct.

The physical qualities, such as forgeability, machineability, responsiveness to heat treatment, together with the great strength and toughness of these steels, are such that for structural steel elements such as those entering into the manufacture of machines, automobiles, aeroplanes, etc., where strength and toughness are necessary to meet service conditions, they will be used with the best results. Among such elements may be mentioned gears, crank shafts, connecting rods, shafts, springs, cams, bearings, etc.

Conference on Employment and Vocational Education.—Acceptances already received from invitations to the conference on employment and vocational education which is to be held in the Congress Hotel in Chicago on Nov. 12, indicate that at least 500 employers, employment managers, representatives of employment bureaus and educators will be present. The conference, which is sponsored by the American Association of Engineers, will consider the problems of employment which are confronted by non-commercial employment bureaus and will discuss the relation between employment service and education. Placing the graduate in his first position is the subject of an address to be delivered by A. B. Crawford, director of the bureau of appointments of Yale University. The attitude of the employer toward the man placed in his employ by the employment bureau will be outlined by Frank D. Chase, president of Frank D. Chase, Inc., of Chicago, who has named his talk "What the Employer Requires When Engaging an Engineer." Employment office administration will be discussed by George P. Hambrecht, chairman of the Industrial Commission of Wisconsin. The relation between education and industry will be explained by John B. Densmore, director-general of the United States Employment Service. Possibly one of the most important addresses is that to be delivered by James P. Munroe, vice-chairman of the Federal Board for Vocational Education, entitled "Vocational Advisement as a Prime Function of Vocational Education." The attendance at the conference is not limited, but although several thousand invitations have been sent out it has been impossible to communicate with everyone who would like to attend the conference. An invitation is extended to everyone to attend. No card of admission is necessary. The morning session commences at 9 a. m.; the afternoon session at 2:30 p. m., and the evening session at 7 p. m. At 11 a. m. the morning session will divide into four group meetings: employers and employment managers; employment bureaus; representatives of educational institutions, and general employment discussion.

142-Ft. Span Concrete Girder Bridge

Two unusually long concrete girder spans make up a new highway bridge recently constructed over the Salt River in Humboldt County, Calif. Each span is 142 ft. between centers of support, which is believed to be far in excess of the longest reinforced concrete girders heretofore built. The following details of this bridge are taken from The Architect and Engineer.

The spans are identical. Each consists of two concrete girders 12 ft. deep, carrying at 20-ft. intervals (21-ft. spans at each end) floor beams, between which the 5-in. concrete floor is carried on 9x20-in. reinforced concrete stringers spaced at the third points of the floor beams. The main section of the girder is 7 in. thick, enlarging by steps to 24 in. at the top and 18 in. at the bottom, and with pilasters opposite the floor beams stepping up to maximum width of 30 in. and thickness of 18 in.

Underside of Bridge.

Each main girder is figured as a straight girder loaded for floor-beam reaction. The steel, however, is continuous over the center pier, no expansion joint being provided at this point. The design was made for a uniform live-load of 70 lb. per square foot over the entire road surface or a 15-ton road roller, in accordance with the theory and tabulation in Ketchum's "Design of Highway Bridges." As classified in that text, this bridge would be classed "E—ordinary county highway bridges." Calculation of stresses under dead—and alive—load gives a maximum compression of 1,100 lb. per square inch and a maximum shear of 226 lb. per square inch in the main girders. Concrete is expected to carry only 60 lb. of the shear, steel being provided for the remainder. Calculated extreme fiber stresses of the steel in the girder range from 12,000 lb. in the top of the bottom flange to 16,000 lb. per square inch in the lower bar. The 21-ft. stringers were stressed less than the main girders. Here the 15-ton road roller stresses govern, while in the design of the main girders the distributed load gave maximum stress. In the stringers the maximum fiber stress of the concrete is 350 lb. per square inch. In the steel a maximum fiber of 16,000 lb. per square inch was permitted and the shear is 145 lb. net section. Because of the likelihood of rusting and corrosion, too, it was decided not to use roller bearings to carry the expansion movement of the girders. Instead a thin sheet of asphalt was poured at each end and 4 in. latitude allowed for expansion and contraction.

The influence of concrete ship design and construction was noticeable in the layout of the reinforcement and in placing the concrete. Steel bars were distributed closely through the flanges of the girders, and, as in the concrete ships, they were separated with spacers. Placing the concrete, too, was facilitated by the use of pneumatic hammer on the forms, as was done in the Government concrete ships.

Reinforcement in the girders was built up to shape in the forms. An opening was left along the upper side of the bottom flange of the forms through which to place the bars below that level, and each layer was fastened as it was placed. The steel used in top and bottom flanges is all 1¼ in. bars, plain rounds, which were delivered on the job in lengths up to 80 ft. In order to avoid the possibility of confusion in placing the steel and to insure a location of joints that would give a sufficient cross-section of continuous steel at any point, there was added to the blue-print an extra sheet on which was plotted the length and location of every longitudinal bar in top and bottom flange.

In the bottom flange there are nine layers of six and five bars each. Each layer was numbered and the successive runs of bars in each layer were lettered. By laying off the length of these bars to scale, one above another, it was possible to tell at a glance where joints would come without interference, and conversely where to put the steel when the time came to sort it out and assemble it on the job. Thus on this special sheet not only was each run of steel identified by letter and number, but the exact length of each piece and its longitudinal position were also specified. In order to secure the necessary amount of steel in all cross-sections without lap-joints, joints were broken at such intervals that such joints could be used in all runs and still maintain the required amount of steel in all sections.

The concrete was poured in five successive stages. The lower halves of the girders were poured first, then the floor system, and finally the upper halves. Under this plan suitable places for making joints could be reached at the end of each day's continuous pouring. Each half of each girder was poured in one day and the floor system was poured in four sections in one day each.

Two grades of concrete were used on the job, one for the girders and one for the floor slabs and floor system. In the girders there was used a 1:1 mix, with the aggregate consisting of 1½ parts sand and 2½ parts gravel, and gravel ranging from ¾ in. as a maximum down to ¼ in., and the sand from ¼ in. to fines. In the floor system a 1:1½:4½ mix was used with the gravel up to 1½ in. maximum size. The 1:1½:2½ mix was found to test from 2,800 to 4,200 lb. per square inch in 28 days.

The falsework consisted of ordinary driven pile bents with sway bracing, such as is used on railroad trestles. Square timber caps were used and above the caps the supports were shored up on shims so that the forms could be accurately lined up just before pouring concrete. The unsupported length of piles varied from 10 to 25 ft. The operations were carried on from one end of the bridge instead of both ends as originally planned. This was due to the failure of the old bridge nearby, which prevented the contractor from delivering materials on the far side of the stream.

Using the design figures with a section modulus of 15, the center deflection of the girders for full load was calculated to be 2 1 16 in. Six weeks after the forms had been removed a deflection of 1¼ in. in the center of the span was reported. Specifications called for a 2-in. camber.

The bridge was designed by Mr. H. J. Brunnier, Consulting Engineer, San Francisco. Mr. A. J. Logan is County Surveyor of Humboldt County.

Charring Does Not Preserve Wood

Charring is of little value in protecting the butts of fence posts and telephone poles from decay. This is shown by service tests made by the U. S. Forest Products Laboratory on fences of charred and untreated posts of various species. The charred posts proved in these tests to be even less durable than the untreated ones.

Theoretically, an area of charred wood around a post should prevent decay, because charcoal does not decay or encourage the growth of fungi. But the charred area around a post is not usually a solid covering. It is checked through in many places. If posts are seasoned before they are charred, the charring does not reach to the bottom of the season checks which are always present. If green unchecked posts are charred, checks will open through the charred part as the wood seasons. In either case the uncharred center of the post is exposed to fungus infection and will decay as rapidly as any untreated wood.

Charring deep enough to resist decay would undoubtedly weaken a post of ordinary size.

Wood Preservative Output in U. S.—Investigation by the Forest Service of the United States Department of Agriculture shows that the use of wood preservative has increased to a large extent in the United States. In 1919 there were 65,556,247 gal. of creosote, 2,412,592 gal. paving oil, 102,611 gal. of miscellaneous preservatives used in the United States, in addition to 43,483,000 lb. of zinc chloride, the largest quantity of this preservative ever reported by the industry. Of the creosote, 6,193,000 gal. were imported.

Reconstruction Progress and City Planning in France*

By GEORGE B. FORD

Director City Planning Department of the Technical Advisory Corporation

The French are coming back. We knew they would but their achievement in the face of the most appalling destruction the world has ever seen is astounding. An area as big as Massachusetts, Rhode Island and part of Connecticut was laid waste but already two-third of it is back under cultivation. More buildings were destroyed than in the whole of Greater New York, and yet not only is almost everything repairable back in use but complete reconstruction is well under way. Three-quarters of the factories are again in operation.

Enough miles of railroad were destroyed to reach from New York to San Francisco, but almost all is not only back in use but is handling much more freight than before the war. Eighteen hundred bridges were destroyed. Almost all are rebuilt and better and more modern than before the war. They are profiting by the destruction of several hundred miles of canals to prepare them to take 600 ton barges instead of 300 ton. Whole mountain sides are being blasted away to repair the destroyed tunnels and great arched concrete retaining embankments are being constructed.

Mistakes of the Past Being Corrected. In their haste to get back on their feet are they just putting back what was there before the war? Far from it, they are profiting by the occasion to correct the mistakes of the past and to start fresh.

Chauny was a knee-high town blown up systematically by the Germans because it was an important industrial city; a menace to German trade. La Renaissance des Cites held a competition for plans for its improvement. The remarkable prize plan has been officially adopted by the city. It creates a large factory district between the railroad and the canal with workingmen's model home communities within easy walking distance.

Soissans always under fire during the war is profiting by the destruction to replace some of her tortuous streets by broad traffic arteries. Arras, Verdun, Cambrai, etc., are doing the same.

Lille, the great industrial center of northern France, is tearing down her choking walls and changing her terminal passenger station into a modern through station and now she is holding a great competition for the planning of all of the contributing area.

Rheims is the first city in France to have its comprehensive city plan adopted by the French government. In these plans I provided for large industrial districts along the railroads and the canals radiating from the center of the city and alternating with workingmen's living districts also radiating. An ample playground was attached to every school by appropriating the centers of deep blocks. Parks and connecting boulevards were distributed around the outskirts. Community center buildings and public markets were located within easy reach. Public and semi-public buildings were given an adequate setting. Many of these ideas and others that we have come to think of as necessities in America were new to them, but they are open-minded and want to do the right thing. The city engineers are often the quickest to grasp the new possibilities and the most zealous to push them.

Marseille and Limoges are wiping out large slum areas and making them into the show quarters of the city.

Lyons, the silk city, has built a great bridge and a big public hospital during the war and is now working on a sewer system and 10,000 workingmen's homes.

Paris has just held a great competition for a comprehensive city plan for all of the surrounding territory. As a member of the jury, I was most struck by the vision with which the judges approached their problem.

Compulsory City Planning Law in France.—What is there in this record that interests us? First and foremost the great fact that France, the first of all countries in the world, voted on March 14, 1919, a compulsory city planning law by which every city over 10,000 inhabitants must make a comprehensive plan for its improvement and every devastated town and village, no matter how small—and there are 2,600 of them—must make a plan for better sanitation, circulation, open spaces, housing, etc., before any permit for any reconstruction can be given.

---

*From a paper presented at the recent convention of the American Society for Municipal Improvements.

Today, already over over a thousand towns have their plans and already the state has approved several hundred of them. One and all they are profiting by the occasion to correct the mistakes of the past and to modernize their towns without losing their character, although I had much ado to persuade some of them not to adopt our nightmare American gridiron plan which so rubber stamps our towns.

Then they have excellent expropriation laws. It was just five days before the armistice that they adopted a most useful excess condemnation law; but for years their laws have permitted them to lay out streets on the map in the bed of which the owner can build only at his own risk and the city assesses benefits and awards damages only when it is ready to expropriate.

Furthermore, for many years they have been widening streets all over France by the same process that has been used in widening Chestnut and Walnut streets in Philadelphia, that is, by striking a building line a given number of feet back from the old street line and then requiring every property owner on rebuilding to set back to the new line. Fully one third of the streets of old Paris are being widened today by this means. As benefits are assessed at the same time damages are awarded, the city, in the long run, secures the widening for a very small outlay.

In 1902 France passed an excellent permissive health law giving cities the right to appoint health boards and to adopt sanitary codes for which the government furnished a model form. The famous war damage act, by which the government pays all war damage in full, also provides that all devastated towns and villages must be made more sanitary and that the government will pay a large part of the cost. The result is that water and sewer systems are appearing all over northern France.

Financing Workmen's Housing.—On workingmen's housing the French government has been loaning money for many years at 2 per cent interest amortizable in not over 25 years. They loan it to a city bureau or to a housing company on condition that they do not charge over 400 to 936 francs rent, depending on the location and the size of the suite, and in no case more than 1¾ per cent of the cost of land and building. The government lends from 60 to 80 per cent of the total cost and private capital invested in the balance must not pay over 4 per cent. The tenant pays from 2¼ to 3½ per cent per annum where he rents and 1/5 down and from 2 to 2½ per cent per annum where he buys. Taxes on new housing are remitted for 12 years. Special inducements are given to the needy, to large families and for the purchase of small farms.

A new bill now before the French parliament provides that the government shall give outright one-half of the cost of land and buildings with a view to the erection of 500,000 workingmen's homes in the next ten years.

The French have always been famous for their roads, mostly macadam with a very thin top crust. They have stood the inevitable neglect of the war remarkably well. Everywhere in the devastated region they are being rebuilt. They rarely use our tar binders and our oils, but they are beginning to use our concrete roads. In Paris everywhere except on the hills they are using wood blocks.

Their canals and railroads in the devastated regions have come back with astounding rapidity, but their great contribution is their light narrow-gauge railways that ramify all over the country. These use light rails and virtually no grading. They proved of inestimable value during the war.

There were no community centers in France before the war, but to-day there are at least four national socities organizing them throughout the devastated regions. The idea is taking hold rapidly, often starting as a workingman's club. They serve as an excellent counteractive for the saloon.

Beauty and charm has always characterized the French towns and villages. They are apt to place that which is offensive to the sight before that which is offensive to the sense of smell or of hearing. They insist that their towns shall be attractive, often invoking the police power to that end. The interesting part of it is that it costs little, if any, more than it would if they didn't insist. They appreciate the fact that attractiveness in their surroundings is an economic asset. It pays.

Reconstruction Co-operation.—Finally, to realize their plans the French have developed vastly of late the principle of "co-operation." Over 1,000 reconstruction co-operative societies have been founded in the devastated regions, several villages often combining in one. Each society, aside from encouragement from the government, profits by all of the savings entailed in having only one architect and one contractor for the whole group who buy in quantity and ship in quantity, who can organize large shops, burn their own brick and lime and standardize everything that goes into the buildings.

However, the great outstanding contribution of France is the fact that she now realizes that her towns and villages must plan ahead and private property rights must be controlled for the public good. The war has borne in upon her that mistakes of the past must be corrected. She realizes that she owes it to the citizens of the future to plan for them healthy, convenient, comfortable, charming places to live and work in.

Rules and Unit Stresses for Rating Existing Railway Bridges

At a meeting last August of the Committee on Iron and Steel Structures of the American Railway Engineering Association changes in the proposed rules for classifying existing railway bridges were adopted tentatively, and a sub-committee instructed to prepare a draft of the rules as revised for advance publication in the bulletin of the association, in order that the members might have an opportunity to submit discussions in time for them to be considered at the next meeting of the committee, in November. The rules appear in the August bulletin. They are as follows:

(1) In fixing the carrying capacity of any bridge under traffic, its location, design, details, material, workmanship, behavior and physical condition must be taken into account.

(2) Before recalculating an existing bridge, a careful inspection should be made to determine: (a) Whether the actual sections and details conform to the drawings; (b) the loss of metal due to corrosion and wear. This determination should be made by caliper measurements, after thorough removal of scale; (c) the general physical conditions. Defects such as loose rivets, worn pins, cracked metal, etc., should be carefully noted and corrected. Particular attention should be given to the position of track with respect to center line of bridge, and to undesirable details, such as forked ends of compression members, eccentricity in riveted joints and connections, unequal stress in tension members, etc.

(3) In recalculating bridges for increased loading, the equipment in actual use, or which it is proposed to use, shall be taken for determining the live load stresses. Where the design or details are such as to cause unusual eccentric or secondary stresses, these stresses shall be taken into account. It is recommended that stresses in members subject to marked secondary effects be determined by strain gage measurements.

(4) Where speeds may exceed 15 miles per hour, the dynamic increment of the live load shall be added to the maximum computed live load stresses and shall be determined by the formula.

$$I=S\frac{300}{300+\frac{L^2}{100}}$$, in which

I=impact or dynamic increment to be added to the live load stress.

S=computed maximum live load stress.

L=the length in feet of the portion of the span which is loaded to produce maximum stress in the member.

(5) If a bridge is so located that speeds are definitely limited, or where absolute control of speed can be secured, 50 per cent of the impact given by the above formula shall be used when the speed is between 10 and 15 miles per hour, and 25 per cent when the speed is less than 10 miles per hour. If the bridge is located where the locomotive must be started, the speed increased, or the brakes applied, full impact shall be used in the calculations.

(6) Impact shall be added to stresses produced by centrifugal force, but not to those produced by lateral forces.

(7) For bridges on curves, and at other places where tracks are off center, provision shall be made for the increased load

carried by any truss, girder or floor member due to the eccentricity of the load.

(8) In spans exceeding 150 feet in length and in viaduct towers, the effect of lateral (or wind) force shall be taken into account. The lateral force shall consist of a moving load equal to 15 lb. per square foot on the vertical projection of the structure on a plane parallel with its axis and a moving load of 400 lb. per linear foot applied 8 ft. above the base of rail.

(9) On curves, the centrifugal force based on actual speed of operation and assumed to act 6 ft. above the base of rail, shall be taken into account.

(10) The limiting unit stresses resulting from the loads and forces mentioned in the previous articles in combination with the actual dead load, shall not exceed the following, in pounds per square inch.

	Open Hearth Steel	Wrt. iron and Bessemer Steel
Axial tension (net section)	[illegible]	22,000
Axial compression (gross section)	$24{,}000 - 100\frac{l}{r}$	$20{,}000 - 80\frac{l}{r}$
but not to exceed	20,000	17,000
Tension in extreme fibers of rolled shapes (except rolled beams), built sections and girders (net section)	[illegible]	22,000
Tension in extreme fibers of rolled beams (net section)	24,000	20,000
Tension in extreme fibers of pins (figured by assuming stresses concentrated at centers of bearings)	60,000	50,000
Shear in plate girder webs (gross section)	18,000	15,000
Shear in rivets and pins	22,000	14,000
Bearing on rivets, pins, outstanding legs of stiffener angles and other steel parts in contact	44,000	28,000

The above mentioned values for shear and bearing shall be reduced 20 per cent for countersunk rivets, floor connection rivets, and turned bolts.

(11) In members subject to stresses produced by a combination of dead load, live load, impact and centrifugal force with lateral forces, or bending due to lateral action, unit stresses 25 per cent greater than those given in Article 10 may be allowed; but, in such case, the unit stresses due to dead load, live load, impact and centrifugal force alone shall not exceed those given therein.

(12) In hangers having an unequal distribution of load, consideration should be given to the necessity for reducing the allowable unit stress to meet this condition.

(13) The stress per square inch in the compression flanges of plate girders shall not exceed.

$$23000 - 400\frac{l}{b}, \text{ for Open Hearth Steel,}$$

$$\text{and } 19000 - 300\frac{l}{b}, \text{ for Wrought Iron and Bessemer Steel,}$$

in which l=the length of the unsupported flange, between lateral connections or knee braces.
b=the flange width.

(14) Plate girders shall be computed either by the moment of inertia of their net sections, including compression side; or by assuming that the flanges are concentrated at their centers of gravity. In the latter case, one-eighth of the gross section of the web, if continuous or properly spliced, may be used as flange section. For girders having unusual sections, the moment of inertia method shall be used.

(15) When the calculated stresses exceed the foregoing limits, or when the design or physical condition makes it necessary, the structure shall be strengthened or renewed.

New Type of Brick Wall Construction.—The City Council of Los Angeles, Calif., has approved an amendment to the city building ordinance, allowing the use of an 8-in. hollow wall built of solid brick. In this construction bricks are laid on edge, giving a 2-in. section on either side of a 4-in. air space, and are bonded together with header brick, laid on edge, 8 in. apart, in every course. Following the ordinary method of laying brick the headers give a Flemish bond. The ordinance requires that such walls be laid with mortar composed of 3 parts of rich lime mortar and 1 part of cement. They may be used only in 1-story buildings where the height of the story does not exceed 9 ft., erected outside fire limits Nos. 1, 2, 3 and 4. Three courses of solid brick wall are required at the top under all ceiling and roof joists. The length of the wall, unless supported laterally, is limited to 24 ft.

The New Joint Committee and Standard Reinforced Concrete Design

By EDWARD GODFREY

Consulting Engineer, Monongahela Bank Building, Pittsburgh, Pa.

The American Concrete Institute hurried through a new set of building regulations in anticipation of the newly organized Joint Committee so as to beat them to it. They incorporated (1) a low standard for flat slabs, (2) the rodded column with a high unit stress, (3) excessively high unit shear on beams, (4) and stirrups or short shear members, so-called. This was apparently done in the hope that by repeating these unsubstantiated and undefended methods of design a sufficient number of times they can create truth that never existed—at least making themselves believe these things are true.

Here are some truths that are hard to get around and hard to square with the common standards of reinforced concrete design, and which no engineer can deny, at any rate, after repeated public statements covering a period of years they are yet to be challenged.

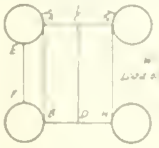


Fig. 1.

(1) No critical test of a flat slab unit nor of a flat slab building was ever made and published. A critical test on flat slab construction is either a test on an isolated unit without balancing loads, a test on a row of bays across a building, or a test on a row of bays along the outside edge of a building where there is no outside supporting girder. Only such tests discover the strength of a flat slab.

(2) No tests have ever been made and published on rodded columns in construction resembling a building that have shown up well in the test. By rodded column is meant a concrete column with a rod near each corner and with or without steel ties at intervals of a foot or so. The only test the writer is able to find where the construction resembled a building is described in Engineering Record, Sept. 30, 1905. Here four columns supported two girders and a slab between them. The columns failed at the extremely low load of 300 lb. per square inch, very much less than the alleged safe unit loads found in the standard regulations.

(3) Rodded columns in many laboratory tests have proven to be weaker, in carefully tested specimens, than plain concrete columns. No engineer who values his reputation would dare to use plain concrete columns, even though the Joint Committee Report of 1913 allowed such columns.

(4) The actual sum of the bending moments in a flat slab along the lines AB and CD, Fig. 1, proven by mathematics that no engineer can dispute, is $\frac{1}{8}$ WL^2; and this is 15 per cent greater than the American Concrete Institute Regulations require in design for the sum of the bending moments along the lines AEFB and CD, where the sum of moments must be greater than along AB and CD.

(5) No analysis of the stress in stirrups placed in the standard way (nor of short shear members nor of bent-up parts of rods not anchored) can possibly be made, and these three methods of reinforcing for shear or diagonal tension are the only ones recognized in most books and in most standards.

(6) Harmonizing with (5) tests have proven that no stress of any considerable amount, particularly no tension, can exist in the shear reinforcement, so-called, of beams of these standard designs, unless the concrete web has failed by cracking. Tensile stress is the thing apportioned to the alleged shear reinforcement by standard regulations and that in conjunction with a whole web, otherwise there is the anomaly of a broken web taking a portion of the shear.

(7) Standard regulations (the Joint Committee Report and the American Concrete Institute Regulations) do not require any provision whatever for shear or diagonal tension reinforcement in the part of the beam where these stresses are the greatest; that is, for ½d adjacent to the support.

(8) Among the few laboratory tests that seem to be aimed to duplicate the conditions in a building are a lot made by Withey, described in Bulletin No. 175 University of Wisconsin. They are continuous beams and loaded as such. A large number of these tests broke with diagonal cracks exactly at the supports, exactly where another experimenter states that a thousand laboratory tests he witnessed did not break exactly where the Joint Committee Report and the A. C. I. Regulations are careful to tell us beams do not break, and exactly where these standards do not require shear reinforcement, even if the shear is equal to 6 per cent and even 12 per cent of the ultimate strength of the conerte.

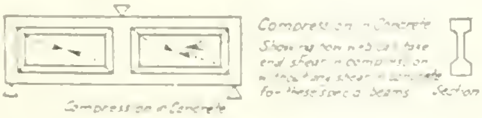


Fig. 2.

(9) A large number of beams and girders in buildings and bridges have broken off at the support, carrying the inadequate reinforcement with them. Some of these girders were of seasoned concrete in use in bridges many months. Standard design would require no reinforcement across the sections that broke, for the standards specifically state that no shear reinforcement is needed close to the supports in beams and girders.

(10) The widely heralded tests that purport to prove that concrete beams can carry shears equal to 2,000 lb. per squaro inch on the web are misleading and wrongly interpreted. These tests are the warrant for the excessively high unit shears recommended by the A. C. I. regulations.

As shown by Fig. 2, the concrete web did not need to take shear at all after the first failure, but could carry its share of the load of the girder in simple compression. The diagonal tension cracks would not destroy the capacity of the web to take this compressive stress.

The significance of the foregoing statements will be perfectly clear to anyone familiar with reinforced concrete design and analysis. No end of opportunity has been held out to engineers to refute these statements. No serious effort has been made to do so, though many endeavors have been made to discredit their propagator and thus draw attention away from the poignant truth of the statements.

The committee of engineers, no matter what their standing may be in the engineering world, that attempts by mass action to perpetuate the discredited standards of the American Concrete Institute Regulations is only laying up wrath for the profession.

Hooping for Concrete Stave Coal Pockets and Grain Tanks

The August issue of Concrete gives the following information on the hooping of concrete stave coal pockets and grain tanks; the figures being based on data supplied by the National Cement Stave Silo Association:

SIZE AND SPACING OF HOOPS FOR CONCRETE STAVE COAL POCKETS—THIS TABLE IS FOR ROUND RODS WITH ROLLED THREADS

Dist from Top. in ft.	12 ft. Diam.	14 ft. Diam.	16 ft. Diam.	18 ft. Diam.
0-10	9/16"-15" ctrs	9/16"-15" ctrs.	9/16"-15" ctrs.	9/16"-15" ctrs.
10-20	9/16"-15" ctrs.	9/16"-15" ctrs.	9/16"-15" ctrs.	9/16"-10" ctrs.
20-30	9/16"-15" ctrs	9/16"-15" ctrs.	9/16"-10" ctrs.	9/16"-10" ctrs.
30-40	9/16"-15" ctrs	9/16"-15" ctrs.	9/16"-10" ctrs.	9/16"-10" ctrs.
40-50	9/16"-10" ctrs.	9/16"-10" ctrs.	9/16"-10" ctrs.	9/16"-10" ctrs.
50-60	9/16"-10" ctrs	9/16"-10" ctrs	9/16"-10" ctrs	9/16"-10" ctrs.

SIZE AND SPACING OF HOOPS FOR CIRCULAR CONCRETE STAVE GRAIN TANKS OF VARIOUS DIAMEERS AND DEPTHS. UPPER FIGURES GIVES SIZE OF HOOPS WITH ROLLED THREADS—LOWER FIGURES GIVE SPACING.

Dist. from Top In ft.	8 ft Diam rd rod In	10 ft. Diam. rd rod In	12 ft. Diam. rd rod In	14 ft. Diam rd rod In	16 ft. Diam rd rod In	18 ft. Diam. rd rod In.	20 ft. Diam. rd rod In.	22 ft. In.
0-5	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15
5-10	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15
10-15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 10
15-20	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 10	9/16 10	9/16 10
20-25	9/16 15	9/16 15	9/16 15	9/16 15	9/16 15	9/16 10	9/16 10	9/16 7½
25-30	...	9/16 15	9/16 15	9/16 15	9/16 10	9/16 10	9/16 10	9/16 7½
30-35	...	...	9/16 15	9/16 15	9/16 10	9/16 10	9/16 7½	9/16 7½

Determination of Stress-Deformation Relations for Concrete Under Repeated and Continuous Loadings*

By STANTON WALKER.

It is worth noting that Mr. Williams is in disagreement with most investigators when he concludes that the stress-deformation relation for concrete is linear for stresses lower than 50 to 70 per cent of the ultimate strength of the concrete.

In a paper† on the modulus of elasticity of concrete which the writer presented to the American Society for Testing Materials in 1919, data from tests made at the Structural Materials Research Laboratory, Lewis Institute, Chicago, were presented which showed that the stress-deformation relation for concrete may be represented by an exponential equation of the form—

$$s = Kd^n \quad \ldots\ldots (1)$$

Where s = compressive stress in concrete

d = unit deformation of concrete

K = a constant, depending on the strength of the concrete

n = an exponent, approximately the same for all conditions.

In Table 1 stress-deformation data are tabulated for four different concrete mixtures. Each value for strength and deformation is the average of 80 tests of 6 by 12-in. cylinders made on 20 different days. The specimens were made and tested in accordance with our regular laboratory practice.

The materials, the method of molding and the condition of storage were alike for all specimens. The method of testing was the same in all cases except that for each mix deformations were measured over four different gage lengths; 20 specimens were tested using a 4-in. gage length, 20 using a 6-in. gage length, 20 with an 8-in., and 20 with a 10-in. gage length. It was considered proper to average the unit deformation obtained for the different gage lengths since they were essentially the same. The deformations were measured by means of an averaging compressometer equipped with a 0.0001-in. Ames dial.**

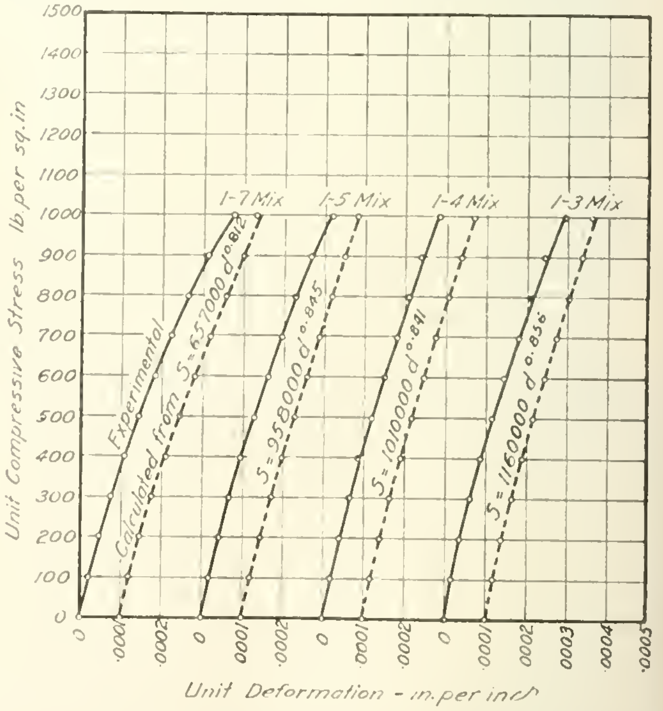


Fig. 1—Stress-Deformation Relation for Concrete.

Compression tests of 6 by 12-in. cylinders.—Mix by volume.—Aggregate sand and pebbles graded 0-1½ in.—Relative consistency of concrete, 1.00.—Specimens stored in damp sand, tested damp.—Each value is the average of 80 tests made on 20 different days.

---

*Discussion at the 23rd annual meeting of the American Society for Testing Materials, Asbury Park, N. J., June 22-25, of a paper presented by G. M. Williams. Mr. Williams' paper was abstracted in the Aug. 25 issue of Engineering and Contracting.

†Proc. Am. Soc. for Testing Materials, Part II, 1919.

These data are platted in Fig 1. The solid lines represent the experimental values. It will be noted that all of them show a slight curvature. The constants for Equation 1 were calculated for the solid lines and the corresponding graph is shown by the dotted lines. The deformations calculated from Equation 1 are also tabulated in Table I. It will be seen that there is an almost exact agreement between the experimental and calculated values.

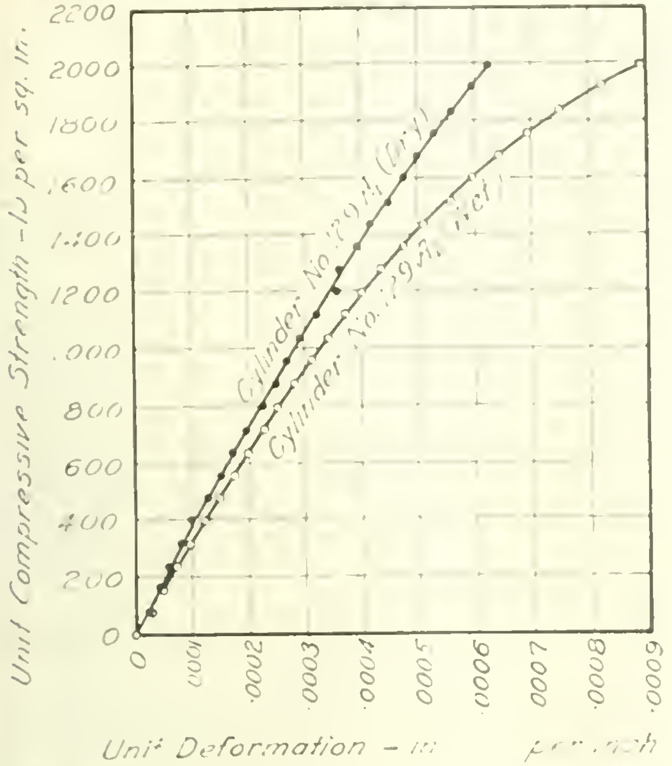


Fig 2—Effect of Moisture Content in Concrete on Its Modulus of Elasticity.

COMPRESSION TESTS OF 8 BY 16-IN. CONCRETE CYLINDERS 1:2:4 LIMESTONE CONCRETE

Cylinder No.	Age at test, days.	Storage condition.	Modulus of elasticity, Lb per sq. in (at 600 lb.)	Compressive strength Lb. per sq. in.
129A	469	7 days under wet sacks and 462 days in air.	3,700,000	3,630
129A	462	7 days under wet sacks, 434 days in air, 21 days in water.	3,150,000	2,340

We have in our files sufficient data to give thousands of examples corroborating the information brought out by these tests. The vast majority of all our data would indicate that the usual form of the stress-deformation relation for concrete is curvilinear throughout the entire range in stress.

It would seem to the writer that the tests from which Mr. Williams concludes that the modulus of elasticity of wet and dry concrete is the same, other conditions being equal, are open to two serious objections:

(1) The age of the concrete varied from 4 to 16 weeks, it is an established fact that concrete 10 weeks old should be stronger than that 4 weeks old.

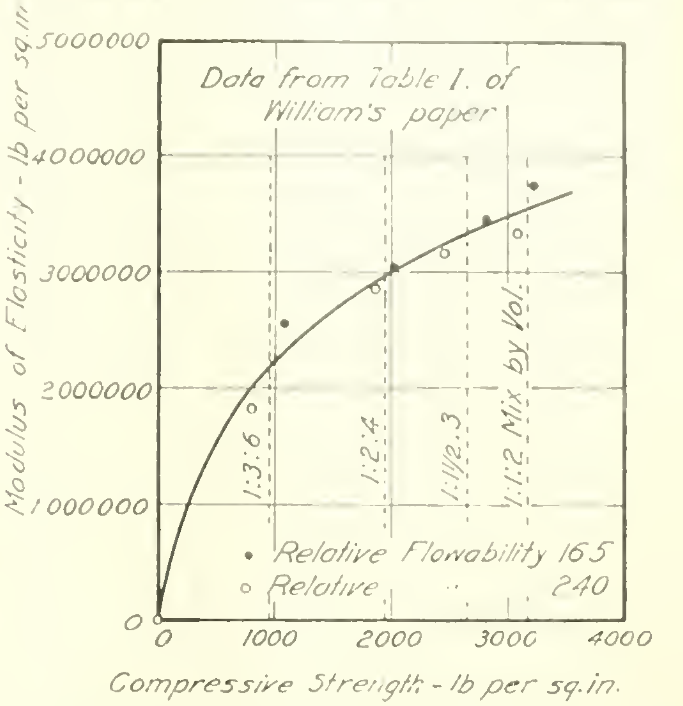


Fig. 3—Relation of Modulus of Elasticity to Strength of Concrete. (Data from Table I of Williams' paper.)

(2) The concrete had been loaded one or more times previous to test for all conditions but one—the test at four weeks.

It would seem that these variables create a sufficient confusion of conditions to cast doubt on the author's conclusions.

The necessity of loading the specimens more than once might have been eliminated by making a number of test pieces under the same conditions and dividing them into groups for the different storage conditions. The effect of the difference in age of the concrete could have been made negligible by testing the concrete at such a time that the period required for drying out or saturating the specimens would have been only a small percentage of the age at test. Following are the results of such a group of tests:

The "wet" specimens were stored in damp sand until tested at the age of one year. The "dry" specimens were stored

---

**For a description of this instrument see page 519, part 2, Volume 19, Proc. Am. Soc. for Testing Materials, or page 12, Bulletin 5 of the Structural Materials Research Laboratory, Lewis Institute, Chicago.

TABLE I—STRESS-DEFORMATION RELATION FOR CONCRETE (Data from Series 99.)

Compression tests of 6 by 12-in. cylinders.—Hand-mixed concrete.—Mix by volume; relative consistency 1.00.—Cement, a mixture of 4 brands purchased in the Chicago market.—Aggregate, sand and pebbles from Elgin, Ill., graded 0-1½ in.—Specimens stored in damp sand, tested damp.—Each value is the average of 80 tests made on 20 different days.—Deformations were measured for 20 tests, each over 4 different gage lengths; 20 tests for each gage length.

Unit compressive stress. Lb. per sq. in.	Unit deformation—inches per inch. Mix 1-7 by volume. Experimental.	Mix 1-7 Calculated.	Mix 1-5 by volume. Experimental.	Mix 1-5 Calculated.	Mix 1-4 by volume. Experimental.	Mix 1-4 Calculated.	Mix 1-3 by volume. Experimental.	Mix 1-3 Calculated.
100	.000023	.000020	.000019	.000019	.000017	.000017	.000018	.000018
200	47	47	43	43	39	39	39	40
300	74	77	67	70	62	64	62	65
400	109	110	95	100	87	91	89	92
500	144	144	129	129	119	118	112	118
600	182	180	162	160	150	148	146	146
700	224	220	191	192	177	177	178	175
800	264	258	228	221	208	208	207	205
900	312	300	264	254	239	240	242	238
1000	376	330	319	285	282	270	294	265
Ultimate strength, lb. per sq. in.	1780		2580		3120		3480	

TABLE II—RATIO OF INITIAL TANGENT MODULUS OF ELASTICITY TO COMPRESSIVE STRENGTH OF CONCRETE

Mix by volume.	Water-ratio to volume of cement for different relative consistencies .90	1.00	1.10	1.25	1.50	Ratio of initial tangent modulus of elasticity to compressive strength of concrete for different relative consistencies. .90	1.00	1.10	1.25	1.50
1-7	.97	1.08	1.19	1.35	1.62	2300	3060	3000	3700	4060
1-5	.74	.88	.96	1.09	1.31	1520	1610	2300	3120	2500
1-4	.70	.77	.85	.96	1.16	800	1600	1690	2600	3270
1-3	.60	.67	.74	.84	1.00	1120	1350	1420	1660	2580
1-2	.51	.57	.62	.71	.85	1600	1060	1310	1710	2180
1-1	.42	.46	.51	.58	.70	840	910	750	1220	1140
1-⅓	.37	.39	.43	.49	.59	720	890	790	610	1060
					Av.	1180	1430	1610	2090	2550

in damp sand one year and then allowed to dry in the air of the laboratory for one month. These were tested at the age of 13 months. Each value is the average of 5 tests made on 5 different days. The mix was 1:4 by volume. The aggregate 0-1½ in. sand and pebbles. The consistency was similar to that usually used in concrete road construction.

	Wet concrete stored 1 year in damp sand	Dry concrete [illegible] year in [illegible] and [illegible] month in air.
Initial tangent modulus of elasticity, lb. per sq. in.	[illegible]	[illegible]
Compressive strength, lb. per sq. in.	[illegible]	[illegible]

It will be noted that both the strength and modulus of elasticity are higher for the dry concrete.

Mr. M. B. Lagaard reported in the Engineering News-Record* data which confirms the above results.

Fig. 2 is a reproduction of Fig. 7 of Mr. Lagaard's article. The deformations were measured on 8 by 16-in. concrete cylinders over a 10-in. gage length by means of a 4-dial compressometer. The readings could be estimated to 0.0001 in.

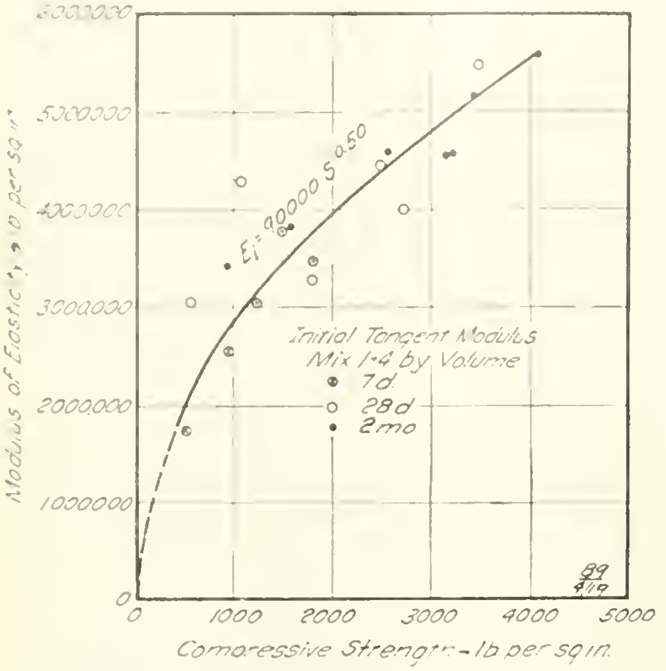


Fig. 4—Relation of Modulus of Elasticity to Strength of Concrete.

Compression tests of 6 by 12-in. cylinders. Sand and pebble aggregate graded 0-1½ in.—Each value is the average of 21 tests from 6 different mixing times.

The curve of deformations for the "wet" concrete is below that for the "dry" concrete, from the beginning of application of load until failure.

In Fig. 3 data given in Table I of Mr. Williams' paper are platted with the unit compressive strength as abscissa and the modulus of elasticity as ordinate. It will be seen that the relation may be represented by a single curve. The values for the neat cement mixture were omitted because Mr. Williams calls attention to the fact that they are erratic, and because we have found in our studies that mixtures richer than about 1:3 do not conform to the general relation.

Figure 4 shows a similar relation for our tests. This figure is the same as Fig. 25 in the paper on Modulus of Elasticity of Concrete mentioned above.

From the relation found in Fig. 3 and 4 we believe that had Mr. Williams investigated concretes of a wider range in flowability, using aggregates with a considerable difference in the proportion of sand, he would not have formed the conclusion that for a given mix and size of aggregate "the ratio of modulus of elasticity to compressive strength of concrete is fairly constant, regardless of the consistency or flowability."

Although Mr. Williams did not report the quantities of water used, a narrow range is indicated from the fact that concrete of the dry consistency has a strength only 5 per cent higher than the wet consistency for the 1:1:2 mix, 16 per cent higher for the 1:1½:3, 9 per cent for the 1:2:4, and 35 per cent for the 1:3:6 mix.

Table II gives the ratio of Initial Tangent Modulus to compressive strength calculated from the results of tests in Table XIII in our paper on the Modulus of Elasticity of Concrete. The test specimens were 6 by 12-in. cylinders and were stored in damp sand until tested at 28 days. The aggregate was 0:1½ in., sand and pebbles. Each value is the average of 5 tests made on different days.

In the same table data are given for a 1:5 mix, using 0:1½ in sand and pebble aggregate for which the percentage of sand varied over a wide range. A fineness modulus of 4.0 gave a ratio of initial tangent modulus to compressive strength of 2,300, a fineness modulus 5.0 gave 2,050, 5.5 gave 1,490, 5.75 gave 1,610, 6.0 gave 1,880, 6.25 gave 1,700 and 6.50 gave 1,990.

It will be noted from these data that the ratio is higher for the wetter consistencies, leaner mixtures and finer aggregates; in other words, the ratio is higher for the weaker concrete. A little study will show that this is in accordance with the information brought out by Figs. 3 and 4, since the modulus of elasticity increases with strength less rapidly for the stronger concrete.

As a point of information the writer would like to know from what tests reported in this paper Mr. Williams forms his conclusions that:

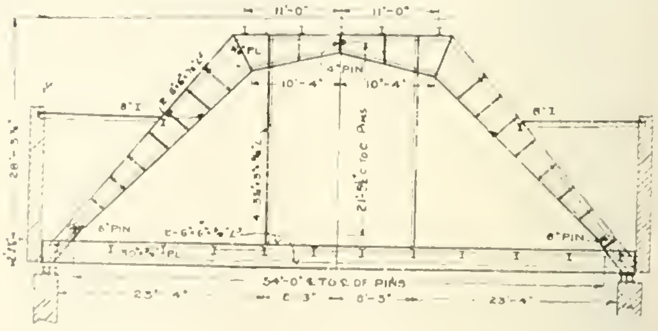
(1) "For ordinary working loads and up to 50 to 70 per cent of the ultimate strength of the concrete, 95 per cent of the value for modulus of elasticity obtained by dividing the unit stress by the unit deformation for that load will represent the true modulus with sufficient accuracy." And

(2) "The value of the modulus of elasticity of concrete in a structure is probably slightly greater than that determined by tests of cylindrical specimens."

Novel Arched Trusses in Ottawa Parliament Building

One of the most interesting features of the steel work of the new Canadian Parliament Building at Ottawa is the arrangement by which the ceiling of the Commons chamber, the floor of the dining room and its roof are carried across a span of some 63 ft. at about the fourth floor level. The method is shown in the accompanying drawing reproduced from The Canadian Engineer, from which this note also is taken. A plate girder with a 30 by ⅜-in. web, and four flange angles 6 by 6 by ⅜ in. at the center supports the floor. A three-hinged arched truss, with each arm shaped like an obtuse elbow, connected with 6-in. pins at the outer end and 4-in. pins at the crown, forms the roof of the restaurant. Hangers from points near the hips of the upper chord support the bottom girder, which is designed as a continuous beam. Six trusses in all are used. This detail gives the Commons a very lofty chamber, even though the elaborate plaster is suspended a considerable distance, and forms a structure in which hanging ceiling lights and domed and carved plaster lend a charm and restfulness to the restaurant.

An unusual method also is adopted to tie in the tops of the outside walls where the rafters of the sloping mansard roof thrust against the high walls at the third floor level. The floor beams carry the lower end of the rafter on a special built-up footing secured to the beams. These beams are tied to those from the court walls to the corridor. Besides this, as an extra precaution, diagonals of tie bars, varying from 4 in. by ⅜ in. to 9 in. by ½-in. plates lead from the outer end of the foot of the rafters to the inner corridor frame. This device is used on the front and the river sides.



Three Hinged Arched Trusses in Ottawa Parliament Building.

---

*See "Saturation of Concrete Reduces Strength and Elasticity," by M. B. Lagaard, Eng. News-Record, Nov., 19[illegible] p. 968.

How to Estimate Interior Mill Work*

By I. P. HICKS

It is the custom with many contractors to send their plans to the mill to get figures on the mill work required. In one way this may be all right because most of the mills have expert estimators to go over the plans and take off the quantities.

To the inexperienced contractor this may be the safest plan, but who pays for this estimating? In all cases the mill man adds enough to the price to pay for the estimating and much more. The man who estimates for the mill has to play safe and make money for the mill. If he did not he could not hold his job as an estimator of mill work. They always add quite a margin above the actual figured cost. Of course we know that it is necessary for them to do this, for they must be sure that they have figured enough of everything and must figure some for contingencies.

However, the contractor who can take a set of plans and accurately take off the quantities of mill work required will be able to save a considerable amount of money on every job. The contractor can just as well figure to save the mill man's safety margin as not.

Many contractors think that taking off the quantities of mill work is such a tedious job that they do not care to undertake it, and then they are afraid that they will overlook some things and be the loser in the end. If you have a system in doing this work and follow it, you can make the work easy and do it with the full knowledge that your figures are right.

Mainly there are only three kinds of trim in general use. These are as follows: Mission style with just a heavy plain head casing. Cap mold trim with head casing, cap and cap mold and a fillet. Back band trim with casings and back band. Each one requires a little different figuring. Where the back band is used no plinth blocks are used and the side casings have to be figured longer. If mitred at the top allowance for this also has to be made. With cap trim you have to add enough of cap and mold to make the returns.

To show just how each should be figured so that the right amounts for each, the proper lengths, the amounts that have to be added and that absolutely nothing shall be missed we will take a window and door openings of given sizes and figure the quantities for each of the different styles of trim.

We will take a window 24x28 two lights size of opening will be 2 ft. 4 in. by 5 ft. 2 in.

MISSION STYLE

	Amt. added. Inches
2 side casings, 5 ft. 4 in. long ..	2
1 head casing, 3 ft. 6 in. long	14
1 stool, 3 ft. 6 in.....	11
1 apron, 3 ft. 4 in....	12
1 head stop, 2 ft. 6 in	2
2 side stops, 5 ft. 4 in	2

CAP TRIM

2 side casings, 5 ft. 4 in	2
1 head casing, 3 ft. 4 in	12
1 cap mold, 3 ft. 10 in.	18
1 head mold, 3 ft. 8 in	16
1 fillet, 3 ft. 6 in......	14
1 stool, 3 ft. 6 in..	14
1 apron, 3 ft. 4 in.....	12
1 apron mold, 3 ft. 8 in	16
1 head stop, 2 ft. 6 in	2
2 side stops, 5 ft. 4 in...	2

Note.—In some styles of cap trim the head mold and apron mold is not used. We put in all the items so that nothing shall be missed.

BACK BAND TRIM

	Amt. added. Inches
2 side casings, 5 ft. 10 in..	8
1 head casing, 3 ft. 4 in..	12
1 stool, 3 ft. 6 in.....	14
1 apron, 3 ft. 4 in........	[illegible]
1 head back band, 3 ft. 6 in	[illegible]
2 side pieces back band, 5 ft. 10 in.	8
1 head stop, 2 ft. 6 in......	2
2 side stops, 5 ft. 4 in. ..	[illegible]

We will now figure for a door opening by the same method. Take a door 2.8x6.8, the opening will be 2 ft. 8 in. by 6 ft. 8 in.

MISSION STYLE.

	Amt. added. Inches
Trim for one side—	
2 plinth blocks (supposed to be 10 in. long)	
2 side casings, 6 ft. 0 in.. .	10
1 head casing, 3 ft. 10 in	14
1 head step, 2 ft. 10 in.	2
2 side steps, 6 ft. 10 in.	2

CAP TRIM

2 plinth blocks, 10 in. [illegible]	
2 side casings, 6 ft. 0 in.	[illegible]
1 head casing, [illegible] ft. 8 in.	[illegible]
1 cap mold, 4 ft. 2 in.	[illegible]
1 head mold, 4 ft. [illegible] in.	[illegible]
1 fillet, [illegible] ft. 10 in.	[illegible]
1 head step, 2 ft. 10 in.	[illegible]
2 side steps, 6 ft. 10 in.	[illegible]

BACK BAND TRIM

2 side casings, 7 ft. 4 in.	8
1 head casing, 3 ft. 8 in.	12
1 head piece back band, [illegible]	14
2 side pieces back band, 7 ft. [illegible]	[illegible]
1 head step, 2 ft. 10 in.	[illegible]
2 side steps, 6 ft. 10 in.	[illegible]

Bear in mind the following facts: That a window opening is nearly always 1 in. wider than the width of glass and 6 in. longer and the amounts we have added gives a plenty to cut on. Also remember that if you have twin windows or triple windows, you must add an additional 6 in. for each mullion as well as the width of the windows to all of the head and stool and apron trim. Don't forget that all doors except outside doors have to be cased up on both sides, so it takes double the amount for inside doors except for the stops.

Pay particular attention to the items listed in this article and the amounts we have added to work on. Be sure you figure the size of your openings right and be sure that you count up the number of openings of each size correctly, the ones that are cased on one side and those that are to be cased on both sides. It will pay you to take particular pains in carrying out this system.

It is well worth your attention, for in just a little figuring in this manner you can rely upon the exactness of your figures even better than if figured by the mill man, and furthermore you will save yourself a good many dollars on the average job.

---

*From National Builder.

Increased Compensation for Engineering Employes of New York City

Under a recent general readjustment of salaries of municipal employes in the city of New York the compensation for all positions carrying a salary of less than $7,500 per annum has been increased. In the case of salaries of less than $1,500 the increase is at the rate of 22 per cent, with a minimum of $200. In the case of salaries ranging from $1,500 to $2,500 per annum the increase is 20 per cent. To salaries upwards of $2,500 per annum $500 has been added, but salaries plus increases have been limited to a maximum of $7,500.

The effect of these increases upon the compensation of the engineering force of the city as organized near the close of last year is shown in the following table, which also gives a comparison with the average compensation for the same positions as fixed before the shrinkage in the value of the dollar became pronounced. All of the positions are classified on the basis recommended by Engineering Council's Committee on Classification and Compensation.

Position.	No. of employes.	July 1 1915.	Ave. salary after Aug 20, 1920.	Per cent Increase.
Chief engineer (including deputy chief engineer) .	20	$7,270	$7,150	2
Engineer	50	3,850	4,470	16
Senior assistant engineer .	86	2,850	3,420	20
Assistant engineer	171	2,180	2,760	27
Junior assistant engineer	56	1,630	2,370	45
Senior aid (chief instrumentman and chief draftsman)	61	1,700	2,140	44
Aid (instrumentman and draftsman)	285	1,500	2,150	45
Junior aid (junior draftsman and rodman) .	150	1,030	1,720	67

Comparing the present average compensation with the compensation schedule proposed by the committee, it will be seen that the average pay of junior aids and junior assistant engineers under this scale is substantially greater than that tentatively recommended; that the average compensation for aid is practically the same as that proposed by the committee; that the average compensation for senior aid and assistant engineer is very close to the committee's minimum; and that for the grades senior assistant engineer, engineer, and chief engineer the average salary, after the allowed increases have been added and notwithstanding the appreciable betterment in the lower grades, is still approximately $650 to $1,500 per annum below the minimum compensation proposed by the committee.

Engineering the Most Vital of Public Professions*

By HOMER L. FERGUSON

Engineers have a distinct advantage over business men in that they may easily and readily qualify as business men in practically any capacity, and practically no business man, as such, can qualify as an engineer. And so to co-operate individually as engineers all that is necessary is to assert your rights and your duties as business men. And that can be done in any community. Business men, in my experience, welcome it. They are glad to have your advice and there are practically no problems concerning local business administration in which the engineer is not needed and is not welcome.

The only disadvantage the engineer labors under, or the only two disadvantages, so far as partaking in public assemblies is concerned, are, in my judgment, first, a reserved modesty which the practice of engineering rather enforces on a man, and, second, an ability to write a lot better than he talks.

If I could change the engineering courses in the colleges of the United States, I would put in the curriculum the means to teach engineers to think on their feet. All of us know engineers of the highest attainment who, when asked to participate in a problem involving large amounts of new business, frequently act as though they have a "gold brick" to sell. They have been so modest that they have been unable to express themselves forcibly to businsss men, who want quick action, who want to be assured by a more or less dominant note in a man who is negotiating with him.

I started out as an engineer, and, if you will pardon a personal reference, was in a business where the engineering was difficult enough, I believe, but where it depended absolutely for its continuance on public policy—on politics in other words. And along with a great many engineers in my particular calling—that of ship building—we have had to come to Washington year after year for 25 years with our hats in our hands, asking that our business be considered as a national business; as vital to the best interests of the country. We were not listened to. We were considered as lobbyists, and not a line and not a word was written into the law affecting the sea that was desired by any ship owner or ship builder for 15 years. You won't have anything much in any business, nowadays, unless the voice of the profession to which you belong is heard. Take for instance the recent railroad case. I know of a gentleman in Congress who voted in favor of the prohibition of strikes on railroads—I mean, the kind of a strike where everybody agreed to quit and not let anybody else work. Every labor organization in his state went after him and from them he received thousands of telegrams, but he received only one letter, a very modest letter, from a business man, commending him for his stand. Notwithstanding that, there were at least 200,000 business men who thoroughly approved of his stand, but no one said so.

There is such a thing as having brains and experience, but they do not do much good if you keep them to yourself. And that is particularly so here. The danger, as I see it, of any national organization is that it shall be used as a means of partisan politics, or promoting the interests of any particular party or of any particular man. As soon as it takes on that phase it loses its strength as an organization representing the sentiments of any class of citizens or of engineers. As soon as we get into the expert testimony class we lose something of our character as broad-gaged engineers.

The Government work is so vast and covers so many fields that it seems almost impossible for any group of men to grasp it all, and yet, in my judgment, there is engineering in it from start to finish. The things that are in the public mind today like the budget system, the good roads movement, the rehabilitation of the railroads, water power conservation, the fuel question, the question of great central power plants for the conservation of fuel and for the purpose of utilizing railroads to the best advantage, are all in their essence engineering questions, and it thus remains for the engineers to take part in these questions. The difficulty with public service is that you cannot put your finger on the thing that you did, unless, of course, you are a politician, and claim everything.

Work is accomplished by joint action. It is just like the movement of great bodies. Individual glory does not come to any man. The work can only be done through a sense of service and at a considerable sacrifice and effort. But, nevertheless, it needs be done. It needs to be done in a thousand different ways. And engineers, as citizens and as business men, who do not take part in public affairs are entitled to no more sympathy than the man who criticises, for instance, the action of his Government, local, state or national, and yet does not exercise his right to vote and participate in political affairs.

The advantage that engineering influence in the country would have over any other sort of organization, unless it were perhaps the medical man, would come, in my judgment, from their training. If we are taught anything at all it is to recognize the truth when we see it, and to know that red figures cannot be turned into black figures by argument. We do not seek to twist every fact we see into something which conforms to ideas which were inherited, let us say, when we were 21 years old, when we first voted. We seek the truth and speak the truth, and we stand for the one big idea on which the safety of the Republic rests, and that is proper information and education. We stand for the truth. We want the truth to be known, and we should insist that in large matters involving the expenditure of huge sums that it should be known as nearly as it may be known before the work is undertaken.

Now, we have engineering societies which never affiliate with each other much. We get together and congratulate each other once in a while and discuss matters of interest. We seldom discuss things of public interest. We seldom discuss matters in relation to public affairs; and, in the meantime, we have in this country a great group of educated men who come pretty close to running the Government. Of course, the judiciary must be made up of the lawyers, and most of the administrative forces of Government are generally from the legal profession, and a very large majority of the legislative forces of Government are generally from the legal profession. Why? Their education is not more fundamental and no more general than that of engineers. It is because they have been trained to public service. It is because they have been trained to public speaking. Now, in the olden times I daresay the work of lawyers and the work of teachers and the work of preachers was the most important work that could be performed by any man in a public capacity. But who can say now, in these days of modern industry, that the profession of the engineer is not the most vital of the public professions? I believe it; and, as far as business men are concerned I have never hesitated to tell them that the engineer is the vital connecting link, and he is entitled to a voice. He can easily have a voice by simply getting up and being heard.

Much comment is seen in any paper you pick up of labor running the world and of capital running the world. Very little is said of the element of management and of brains. Brains run the world. Without them the vast resources of a power like Russia are inert and worthless; and without them, the millions of men in China, wonderful workers, are worthless. The connecting link between the two comprises those engaged in the engineering profession, and they are the people who have made it possible for the poor to have more than any of our fathers and grandfathers had, and for them to live in a state of comfort and decency wherever they have a mind to work.

Analysis of Ancient Armor.—An analysis and microscopical examination of about one dozen samples of ancient armor from the Metropolitan Museum of Art, New York, made by the U. S. Bureau of Standards indicates that all the samples were made from very pure wrought iron converted into steel by the old cementation process, as would be expected. The carbon determination was made on the entire cross-section as the material of all the pieces was too thin and corroded to obtain samples from different layers. The microstructure indicates that the process used in the production of the original iron was very similar to our wrought iron process. The metal was then carbonized, probably by a supplementary process, hammered into sheets, differing in hardness (i. e., in the amount of carburization) and these sheets welded together. The whole was then hammered into shape and quenched, thus producing the final hardening effect.

---

*Abstract of an address presented June 4 at the Organizing Conference of Engineering Societies.

The Specification Writer and Manufacturers' Literature

The question "In what form would the specification writers in architects' offices prefer to have the data from manufacturers regarding material and equipment?" is one that is important to every architect and specification writer, as well as to every manufacturer of building material and equipment. In a recent issue of "Pencil Points," Mr Louis R. Holske, of McKim, Mead & White, architects, New York City, presents the following interesting discussion of this important question:

At present, though specification writers endeavor to keep files of information issued by manufacturers these files fall far short of being what they should be, for they are incomplete, inconvenient to refer to, and are very often lacking in the kind of data needed in preparing specifications.

It would seem desirable that all such printed matter should be of a size to permit its being placed in a letter file of standard size, that is, not larger than 8½ in. by 11 in. It should not be unduly bulky or inconvenient to handle.

Brochures, portfolios, and other elaborately gotten up pieces of printed matter on heavy paper with excessively wide margins, large type and showy illustrations occupy more space and are more difficult to keep in order than the information they contain usually warrants. This elaborate presentation may be right to put into the hands of the layman. It may make a selling appeal to the prospective home owner, but it is not what the specification writer wants to put into his files.

Much of the matter issued by manufacturers contains too much "selling talk." Pictures of buildings in which the materials or equipment have been used, photographs of the plant and of members of the organization may not be without interest, but they should have no place in a catalogue intended for filing by the specification writer. They encumber his files and the catalogue is likely to be discarded. The data needed should be compactly presented, the catalogue or leaflet should not only be of such size that it will go into the file, but it should take as little space as possible. The matter it contains should be so arranged that the information wanted can be found quickly.

Specifications issued by manufacturers are seldom usable to any considerable extent because they are, as a rule, written very closely about the manufacturer's product; if broader in character and better written they might be helpful. Picking out a bit of information here and there from a mass of useless material consumes a great deal of time and it would be much better if the needed data were concisely stated and well tabulated or indexed.

Aside from the faults in shape, size and makeup of much of the printed matter and in the arrangement of the data in it, there is an even more serious fault in the majority of cases, namely, the lack of much of the data needed. In addition to the dimensions required in providing space for an article of equipment, for instance, there should be measurements that will locate the article in connection with other work.

Full and complete data regarding the manufacturer's product should be given and it would be very helpful in many cases if there were brief notes on the correct practice in installing, or applying or employing the equipment or material, as the case may be, in relation to the building itself or other equipment. For instance, the catalogue of a manufacturer of green houses might well state the usual height of the brick walls of such structures above the finished floor in addition to showing sections of the bars and giving the other details which are not usually included.

Removing Paint from Steel Structures

Concentrated powdered lye dissolved in hot water, with lime added to make the solution thick enough to spread evenly, affords a simple means for removing old paint from steel structures, according to an article by Mr. F. A. McLean in the American Machinist. The mixture should consist of 1 lb. of lye to 3 quarts of hot water. The solution should be applied as soon as it is mixed, by means of a brush and allowed to remain on the surfaces to be cleaned until it is almost dry. If it is then removed it will take the paint with it unless the paint is very old and thick, in which case a second coat of the solution should be applied. Before applying a new coat of paint, the metal should be thoroughly washed with a solution composed of ½ lb. of sal soda dissolved in 2 gal. of warm water. After the soda solution has been applied, the surface of the metal should be wiped or warmed until thoroughly dry. It is stated that a method similar to this is in use by the United States Coast Artillery, for cleaning the exterior parts of big guns and their carriages.

A Pneumatic Way of Cutting Rivets and Breaking Up Concrete

Cutting and backing out rivets by means of the sledge and cutting bar is a tedious and expensive operation. The same applies to the breaking up of concrete with bars and hand sledges. A labor and time saving pneumatic tool which simplifies both of these operations and also is applicable to many other uses has lately been placed on the market. This tool operates on the principle of a pneumatic drill. It differs, however, in that each stroke of the hammer is controlled by the operator. The tool is particularly adaptable to structural steel work. It can be operated in awkward places where it would be difficult to use a maul and chisel, and it also can be used high up where there is limited scaffolding room. The tool can also be used on street work, for cutting out concrete and asphalt and cutting off rivets, tie rods, etc., in street railway track. In this particular work it is claimed that one tool and 3 men will do the work of 10 to 15 men. On one street railway job the tool cut 16 1-in. rivets at rail joints in 2¼ minutes. Some other records claimed for this tool are:

Rivet Cutting Guns at Work in Philadelphia Subway.

In 6¾ hours three men, in steel car repair work, removed center sill and attachments from a wrecked high top hopper car, took out coupler; removed hopper doors; removed the air attachments. This made necessary the cutting off and backing out of 1,113 rivets from ⅝ in. to 1⅛ in. in diameter.

One and one-quarter-inch counter sunk rivets backed out cold at a navy yard, time being from 6 seconds to 28 seconds per rivet. Fourteen ⅞-in. rivets cut off sheets per minute.

In the training school of a shipbuilding yard each gun with three men cuts off 6,000 rivets in 8 hours.

The accompanying illustration shows the tools at work cutting out concrete and rivets in the Philadelphia subway. As will be noted, this particular work was in an unusually awkward location. By the use of these tools, it is claimed that the time of operation was cut in half. The pneumatic tool described above is known as the Cincinnati Rivet Cutting Gun. It is manufactured by the Rivet Cutting Gun Co., 117 East Third Street, Cincinnati, O.

Color of Cypress Heartwood No Indication of Durability

Southern bald cypress is about the most variable in color of any of our native woods, and in different localities is known as red cypress, yellow cypress, white cypress, and black cypress. There is a rather prevalent belief that cypress with dark-colored heartwood is the most durable, but the opinion of the U. S. Forest Products Laboratory is that as far as durability is concerned the color of the wood makes very little difference. In service records obtained by the laboratory, any difference in the length of service of red cypress and yellow cypress appears to be due entirely to a difference in the amount of sapwood in the timbers. Cypress trees with light colored heartwood usually have more sapwood than those with dark colored heartwood, and sapwood is not resistant to decay.

The important thing if durability is desired appears to be to select the heartwood of cypress regardless of its shade

Technical Committee of Construction Federation Studying Conservation of Structural Materials

Among the factors which are operating to increase building costs in certain cities, nothing is more unnecessary than archaic building code requirements. An instance where $100,000 worth of extra material is required in a single building through unnecessarily stringent rulings is known. A steel beam may be cut in two at the mill and one-half sent to one city will be allowed to carry 50,000 lb., while in another city, where safe but economical building code requirements exist, will permit the beam to carry 60,000 lb. The framers of the latter ordinance were conservative and based their stresses on competent authorities but the owners in the first city are taxed heavily for the ultra conservatism of their building code committee.

To expose this situation and aid in leveling the building codes to a safe and sane position, the Technical Committee of the Staff Council of the National Federation of Construction Industries is inaugurating an important study of the situation throughout the country. The Executive Committee, consisting of Wharton Clay, Chairman, Commissioner Associated Metal Lath Manufacturers; B. H. Jillson, Illinois Society of Architects; C. E. Paul, Construction Engineer, National Lumber Manufacturers' Association; Virgil G. Marani, Chief Engineer, Gypsum Industries Association; A. C. Irwin, Engineer, Portland Cement Association; W. Carver, Architect, Common Brick Association, and L. P. Keith, Secretary, are preparing this study and will shortly issue a tabulation showing the stresses allowed by the Bureau of Standards and other authorities. Against this will be shown the building ordinance requirements of the various cities.

One remarkable feature of the work that is developing already is the more sane requirements adopted by the lately framed building codes, indicating that a full understanding of the technique of use of various materials is rapidly being appreciated and no extra useless material is being required by the more modern codes.

It is not the plan of the committee to determine the proper stresses, but to compile them so that building and government officials may have a bird's-eye view of the situation and the building industry in the various cities may realize how much precious material is being required for extra and unnnecessary strength.

Personals

John W. Moran, Victoria, B. C., has been appointed construction superintendent, Dominion Naval Service, with headquarters at Victoria.

P. B. McDonald of New York University presented a paper to the National Conference of Business Paper Editors at Hotel Astor, New York, Oct. 21, entitled "Do Editors Write Well?"

Tris Speaker, manager of the Cleveland Baseball Club, has been presented a block of stock in the Dunn & McCarthy Co., Chicago railroad contractors, by James C. Dunn, president of the Cleveland Baseball Club and president of the contracting company, as a reward for giving Cleveland a champion team. Speaker plans ultimately to devote his time to the contracting business when through playing baseball.

Obituaries

William Burrowes, contractor and builder for more than 50 years in Portland, Me., died Oct. 18, aged 82.

Richard Lamb, a construction engineer, New York City, died Oct. 13, aged 81. He surveyed the Albemarle & Chesapeake canal, planned drainage of the Dismal swamp, built the Norfolk system of sewers and for a time was chief engineer of the Wilmington, Newbern & Norfolk Ry.

William Waters, of the engineering firm of Baker, Carpenter & Waters, 58 Sutter St., San Francisco, died Oct. 16. Mr. Waters came to San Francisco immediately after the fire of 1906 and took an active part in the rebuilding of many of the principal office buildings of that city. In 1914 he was appointed chief of building construction at the Panama Pacific Exposition and manager of buildings during the fair. In 1917 he was in charge of construction of Camp Fremont.

Charles C. Chataway, of Chataway, Walker & Bnynes, land surveyors, Union Trust Bldg., Winnipeg, Man., was killed Oct. 16 in an accident in the elevator of the building. He was a native of Heckfield, Hampshire, Eng. Born in 1869, he came to Winnipeg in 1891, entering upon the business of land surveyor. In 1900 he was appointed inspector of surveys for Yukon territory, and this position he occupied five years.

William Marrigan, a contractor of Port Arthur, Ont., died Oct. 18, aged 59 years. Among the works on which he had been general manager or superintendent are: Ballasting operations on the Intercolonial Ry., New Brunswick Ry., part of the Bangor & Aroostook Ry. in Maine, construction of St. Charles branch, Pictou town branch, and Baie de Chaleurs Ry., St. John bridge, Fredericton bridge, Soulange canal, Welland canal, Port Colborne breakwater, Wellington turning basin, etc.

George E. Datesman, former director of public works of the city of Philadelphia, died Oct. 18, aged 57. Born in Mahanoy City Jan. 21, 1863, he received his training as a civil engineer at Lafayette College, of Philadelphia, from which he was graduated with honors in 1883. He joined the Bureau of Surveys shortly after leaving college, but left the bureau to engage in business for himself in 1888. From 1891 he was identified with the surveys bureau and then with the Department of Public Works, becoming director under the Smith administration.

Industrial Notes

Reineke-Ellis Co., Chicago, have established eastern headquarters at 45 E. 34th St., New York City, with complete production plant, idea room and office, under the management of James J. Davin, lately service manager of the New York Talking Machine Co.

The Alsen Cement Co. of America, Inc., is making improvements at its Alsen, N. Y., works which will involve an expenditure of about $500,000. The improvements include a new stock building, a new hospital, sewage disposal plant, changes in grinding mills and power equipment.

The Cement Gun Co., Inc., has removed its main office from Allentown, Pa., to Cornwall, Bucks County, Pennsylvania, a suburb of Philadelphia, where its vice president and general manager, B. C. Collier, will connect himself in an executive capacity in the distribution of Traylor trucks and farm tractors manufactured by the Traylor Eng. & Mfg. Co.

The Conveyor Corporation of America, formerly the American Steam Conveyor Corporation, Chicago, has retained Clarence C. Brinley as eastern manager of the trolley carrier department. He will be attached to the New York office, 110 W. 40th St., Mr. Brinley formerly was connected with C. W. Hunt Co. He came to the Conveyors Corporation from the Gifford-Wood Co. During the war he was conveyor engineer for the Air Nitrates Corporation.

The John F. Byers Machine Co., Ravenna, O., held its third annual sales conference and convention at Glen Crest Hotel, Ravenna, on Oct. 11th and 12th, with all representatives in attendance, except Los Angeles and San Francisco. Pertinent matters of interest were discussed and plans for 1921 outlined. The company has under construction at the present time a new erecting shop, which when completed, will allow increased production of its auto-crane.

At a recent meeting of the board of directors, J. J. Arnsfield, advertising manager of Fairbanks, Morse & Co., was elected president of the Engineering Advertisers' Association of Chicago to fill the vacancy made by the resignation of A. H. Hopkins, who severed his connection with the C. F. Pease Co. to take charge of the domestic advertising division of the J. Roland Kay Co. Mr. Keith J. Evans, advertising manager of Jos. T. Ryerson & Son, was elected vice-president, and Julius Holl, advertising manager of Link-Belt Co., was elected to the board of directors to fill the vacancy made by Mr. Hopkins' retirement.

The October meeting of the Engineering Advertisers' Association of Chicago was devoted to the discussion of market analysis and sources of advertising data. H. A. Groth, treasurer of the Rankin Advertising Agency, was the speaker of the evening and told some of the methods he has employed in the 20 years that he has specialized in that work. Mr. Groth supplemented his remarks by numerous graphic charts on various subjects, indicating how it is possible to present complete information on any usbject in simple comprehensive diagrams. Informal discussion followed Mr. Groth's address. The November meeting of the association will be given to direct-by-mail advertising.

Elisha S. Williams, vice-president of the United States Rubber Co., died Oct. 8. Mr. Williams was born in Malden, Mass., in 1873, and was educated in the Malden public schools, taking a business course in the Malden high school. He then entered the employ of the Revere Rubber Co., and in the course of a few years became the New England manager, a little later the Chicago manager, and in a year or two was promoted to the position of general sales agent, which in turn, led to his assuming the chief executive position in that company as treasurer, and later president. Jan. 1, 1910, the Revere Rubber Co. was purchased by the United States Rubber Company chiefly because of its desire to secure the services of Mr. Williams, who was then elected president of the Rubber Goods Manufacturing Co. Mr. Williams was largely instrumental in the consolidation of the tire business of the company's subsidiaries by forming the United States Tire Company in 1911, of which he was the president until 1915. In 1915 he was elected vice-president of the United States Rubber Co., in charge of the mechanical goods business. He was also a director of the United States Rubber Co., a member of the operating council, and president of several subsidiary companies.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Hoisting Engines and Derricks—Clyde Iron Works, Duluth, Minn. 176 page catalog illustrating and describing the Clyde hoisting equipment, including hoisting engines and boilers, scraper engines, electric and gasoline hoists, derricks, etc.

Feed Water Heaters, Steam Heating Systems, Etc.—Warren Webster & Co., Camden, N. J. Catalog bulletins of Webster feed water heaters, steam separators, oil separators, traps, valves, expansion joints, and the Webster vacuum system of steam heating.

Industrial Buildings—The Truscon Steel Co., Youngstown, O. 16 page book discussing the relation of the characteristics of a factory building to the morale of employes. Some of the subjects treated are: Appearance of the building, daylight as affecting morale and cleanliness and sanitation. Contains numerous illustrations of modern factories.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm 403 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday

(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday

(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday

(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday

(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., NOVEMBER 3, 1920. Number 18.

Should the Am. Soc. C. E. Join the Federated American Engineering Societies?

Two factions of the American Society of Civil Engineers have been vigorously appealing to the members of that society, one faction in behalf of, the other against joining the Federated American Engineering Societies. An examination of the names of the factional leaders indicates that those who are opposed to joining the Federation are, as a rule, older men than those who favor "going in." The alinement is much the same as that that existed about 12 years ago when the Am. Soc. C. E. was asked to join the other national engineering societies in the ownership of the Engineering Societies Building. The invitation was at first declined, but a few years later accepted. Probably we are about to witness a repetition of that history, for the opposition to joining the Federated American Engineering Societies is apparently great among the older members of the Am. Soc. C. E.

Engineering and Contracting has refrained from expressing an opinion on this matter until all the arguments pro and con had been recorded. We have before us the final appeals of both factions, and we have weighed the arguments. It is our opinion that the American Society of Civil Engineers can not afford to stay out of this Federation. It is perhaps no argument in favor of joining a given organization because nearly all others have joined, but such a fact certainly deserves the most careful attention when the object of the association is to promote general welfare by means which no one opposes.

Those who are against joining the Federated Engineering Societies do not argue that its objects are bad or that its plans of executing them are reprehensible. They merely suggest that the objects are "vague" and subject to revision, and, by inference, that they may become objectionable. If this dread becomes a reality what, we ask, will prevent the Am. Soc. C. E. from withdrawing from the Federation? If men were universally to refuse to join associations because the associations might become obnoxious, then there would be an end to all co-operative effort. We fail, therefore, to be influenced by the bogy of possible evils that may be fostered by the Federated American Engineering Societies.

The next most important objection to the Federation is given thus, by Messrs. George H. Pegram, John W. Alvord, and Arthur S. Tuttle:

> The requirements of membership in the American Society of Civil Engineers demand high personal, technical, and executive qualifications, and are rigidly enforced.
>
> The absence of qualifications for membership in the Federation lets down the bars to almost any society that may incorporate the word "Engineer" in its title. This diversity of standards and interests will prevent the Federation from becoming in any sense a representative body.
>
> To carry weight, engineering prestige must rest on professional attainment and standing rather than on bulk of numbers. The Federation sets up no professional standards whatever. Its one standard is bulk.

But, it may be replied, what have high standards of qualification to do with the question? The Federation is not an association whose functions call for "high standards" of professional attainment. Nor is there any force in the implied contention that the "high standards" of the Am. Soc. C. E. will be underestimated by the public because the Am. Soc. C. E. belongs to a federation of societies some of which have "low standards." As well argue that an individual of high moral standards should not belong to a political party, or to a football team. The public knows next to nothing of the standards of any engineering society, and cares as little as it knows; but even if the public were as well informed on that matter as are the members of the Am. Soc. C. E. themselves, the public could be trusted to discriminate between a society that has high professional standards and an association of societies having heterogeneous standards. It was this same professional "holier than thou" attitude that kept the Am. Soc. C. E. out of the Engineering Societies Building for several years.

It is contended that the Federation is autocratic and not democratic. The same argument would hold against the Supreme Court of the United States.

It is held that the Am. Soc. C. E. "has never yielded control of its actions or policies to others." True, but who is asking it to do so? Its policies are its own. But when it joins the Federation, the Federation's policies will be those of the Federation and not of the Am. Soc. C. E. If the Federation's policies become obnoxious to the Am. Soc. C. E. the remedy is clear—resignation from the Federation.

It is argued that:

> Should the Society join the Federation it would, in the estimation of the public, cease to function as the leading engineering organization, as it has done for 68 years.

This attitude, it seems to us, is little short of professional snobbishness. The editor is a member of four national engineering societies, and reads a great many of the papers printed by them. His professional interests are primarily civil engineering, and he is therefore biased in favor of the Am. Soc. C. E., yet he is forced to concede that, judged by any standards of technical excellence, the average paper read before the Am. Soc. C. E. is no better than the average paper read before the other national engineering societies. What is there, then, that entitles us to regard our civil engineering society as "the leading engineering organization"? Certainly not supremacy in the technical literature written by the members, and certainly not a more marked advancement of the science of engineering attributable to civil engineers. It is true that no engineering society is more rigorous than the Am. Soc. C. E. in requiring long professional practice before full membership is granted, but when did length of experience entitle any professional man to claim "leadership" in his profession? Pre-eminence is not measurable in terms of practical experience, nor even in terms of education. By what criterion, then, can an individual or a society be judged when professional excellence is claimed? To our way of thinking there is but one criterion, the criterion of economic achievement; and by that criterion what civil engineer has the hardihood to maintain that the American Society of Civil Engineers excels the American Institute of Electrical Engineers, for example? Do we not betray "a certain condescension" when we look patronizingly down upon other engineering societies, and a not uncertain egotism when we call ours "the leading engineering organization"? Indeed, while thus calling ourselves "leaders" are we not proving ourselves to be reluctant followers? Who are the real pioneers today—those that hark back to their birth 68 years ago, or those that, forgetful of their youth, decide to venture upon a new movement for the benefit of the entire engineering profession and, in fact, of all humanity?

An Example of Erroneous Reasoning About Interest Rates and Commodity Prices

It is somewhat surprising to an engineer that anyone reasoning deductively from assumed premises, should not attempt to confirm his conclusions by a study of ascertainable facts. Yet it is apparently seldom that the average writer on price levels, interest rates, etc., takes the pains to confirm his reasoning by an appeal to statistics. For instance a recent editorial article in The Iron Age contains the following argument:

> A curious fallacy gained ground in some quarters, that since commodities had gone up, interest rates were entitled also to go up. Obviously there was no proper comparison, for the interest rate is a proportion, not a value. One might as well urge that as [illegible] had gone up a man should spend a larger percentage of [illegible] for his noonday luncheon than formerly.

This reasoning sounds so plausible that the editor of The Iron Age doubtless regarded it as wholly unnecessary to look up any statistics relative to the movement of commodity prices and interest rates. He appears to have thought, "What is the use of studying data when I know in advance that the figures will confirm my deductions?" But facts have, at times, a perverse way of failing to agree with deduced conclusions, and this happens to be one of those times.

In a "Century of Prices," by Burton and Selden, will be found charts showing commodity index prices and bond interest yields not only in America but in England, year by year for more than 60 years in America and twice that long in England. These charts establish beyond question that interest rates do rise and fall as commodity prices rise and fall, and roughly in the same proportion. The bond interest rate curve, in other words, is approximately parallel to the commodity price curve, although it lags somewhat behind the commodity price curve. So the "curious fallacy" that the editor of The Iron Age attempts to expose proves to be a truth.

Let us now look more closely at the reasoning of the editor of The Iron Age. In essence it is this:

(1) Certain causes affect values.
(2) Interest rates are not values.
(3) Those causes do not affect interest rates.

This is an illegitimate conclusion from the premises. Moreover, although an interest rate is not in itself a "value," it is one of two factors which multiplied together measure a value, the value of the investment being the other factor.

The analogy between a man's income and the per cent thereof spent for his lunches is not a complete parallelism, for there is no argument as to percentages as such, but as to what ratio one value may be to another value. The annual income from an investment is one value, the selling price of the investment is another value. The ratio of the first value to the second value is an interest or profit rate. There is no reason why this interest rate should remain constant when commodity values in general are changing. But the attempt is made to induce the reader to accept such a constancy of rate as plausible, becuse most men spend a constant percentage of their income for food.

We have given this example of false reasoning because it illustrates three very common errors: First, a faulty syllogism. Second, an inapplicable analogy. Third, a failure to test the conclusion by an analysis of existing facts. Many engineers still regard a study of logic as being unnecessary. They think that their native reasoning powers, and their scientific training will suffice always to protect them from errors in reasoning. Although they may reason correctly 99 times in 100, or 999 in 1,000, there is inevitably a small percentage of error in the mass of any man's inferences. The function of logic is to reduce that percentage of error, small though it may be, to a still smaller fraction. Bear in mind that a small percentage of error is not equivalent to an error that is small. Some of the most costly mistakes in life are made by men whose mistakes are relatively few.

Why Civil Engineers Should Guide Legislators Relative to Bond Interest Rates

County engineers in Indiana have been including bond discount in their estimates of cost of roadwork, hoping thus to overcome the difficulty of marketing low interest rate bonds. It was intended to pay the contractors in bonds, they being thus protected from loss when they marketed the bonds at less than par. But the State Board of Tax Commissioners has refused to approve any county bond issues that are to be thus marketed. Probably the Commission is entirely justified in this ruling, but it should serve to arouse civil engineers in Indiana—and, for that matter, in every state—to the necessity of securing amendments to state laws permitting higher interest rates on public bonds.

In Illinois the legislature recently increased the bond rate from 1.5 per cent to 5 per cent. Had the civil engineers of Illinois presented data on interest rates, past and present, the legislature might have become convinced that even 6 per cent is none too high a limit to fix. Singularly enough, most men think that interest rates are relatively stable, and that they fluctuate within narrow limits, except during some very short and unusual periods of excessive money stringency. The fact is, however, that bond interest rates move in great sweeps upward or downward, following the movement of commodity prices. For eight years after our civil war, the yield of "gilt edge" corporation bonds remained above 7.5 per cent, and then fell slowly till the low ebb of 3.8 per cent was reached in 1901. Since then bond yields have been rising, until now they average about 7.5 per cent for bonds that are not exempt from taxation. It is reasonably certain that bond interest rates will remain high for several years, probably for 8 or 10 years.

If engineers do not submit such statistical facts to legislatures, who will? Are not engineers the only class of men thoroughly qualified to analyze economic data of this sort and present the results in convincing fashion to legislators?

A History of The World That Engineers Can Enjoy

By P. B. McDONALD

Assistant Professor of English, College of Engineering
New York Univ.

A history of the world that engineers can read with interest is now available. The author is H. G. Wells, and over 200,000 copies have been sold in England where the early publication was in 24 fortnightly pamphlets. The history is now being published in book form in one volume, both in England and America.

Engineers are naturally interested in the history of engineering, but no readable book on this important subject has yet appeared. The next suggestion is a history of science, and many engineers have read such histories with interest. History of science naturally leads to a background of the history of life and of civilization, which Mr. Wells has attempted in this "Outline of History." The book is exceptional in that the author has taken a very broad view of the whole subject; moreover, Mr. Wells is a scientist by education and a modernist by temperament. Anyone less conceited than he would not dare attempt such a sweeping survey of things. However, conceited people are interesting if they have special ability to back up their claims. The ordinary pedantic historian would stand aghast at the suggestion of writing a history of the world, particularly one as interesting as this one. He would prefer to take a short period of one country, and elaborate minutiae so painfully that few would ever read the book.

Like the bold man that he is, Mr. Wells begins at the beginning, with the primitive sea life of the Palaezoic age. Soon he is up with the pterodactyls and dinosaurs. Whether mammals, to which class of vertebrates we belong, came in before the huge dinosaurs disappeared, is a question, says Mr. Wells. "The Mesozoic mammals or mammal-like reptiles, for we do not know clearly which they were, seem to have been all obscure little beasts of the size of mice and rats, more like a down-trodden order of reptiles than a distinct class, probably they still laid eggs and were developing only slowly their distinctive covering of hair. They lived away from big waters, and perhaps in the desolate uplands, as marmots do now; probably they lived there beyond the pursuit of the carnivorous dinosaurs. Some perhaps went on all fours, some chiefly went on their hind-legs and clambered with fore limbs." Such was the transition from reptiles to mammals, which prepared the way for man and our modern beasts.

Next Mr. Wells discusses the Java ape-man, or at least the "little trayful of bony fragments" from Trinil, Java, which constitutes, apart from stone implements, the oldest relic of early humanity that is known. The British writer Hilaire Belloc, in the "Dublin Review," has ridiculed Mr. Wells and all similar "modernists" for building up a theory of prehistoric life from a few scraps of bones, stone implements, etc. From the period of the Java ape-man, perhaps half a million years ago, Mr. Wells leads the reader to a description of the early Palaeolithic man, as taken from Worthington Smith's "Man, the Primeval Savage." The description, which dates back to the scene some 50,000 or 100,000 years ago, is that of a bull-like old cave-man with his women and children, tending a fire, hammering flints, and scraping the skins of animals for clothing. When the boys grew big enough to arouse the jealousy of the old man he would kill them or drive them off; but when the old man was 40 or 50 years old his energy declined and some younger man killed him and reigned in his stead. This was the Neanderthal man, who lived in caves and wandered about Europe for tens of thousands of years. He was exterminated by a superior type perhaps 20,000 years ago.

Fascinating pictures are given of early civilization. How sowing was learned by the scattering of grain around a corpse for its sustenance in the other world; how religion profoundly influenced the life of early tribes; how science arose from man's wonder at nature; how myths and magic have persisted down to the present. The Neolithic man, says Mr. Wells, began acquiring numbers. He started counting and talking under the spell of numbers. He was beginning to use tallies, and wondering at the triangularity of three and the squareness of four, and why some quantities like twelve are easy to divide in all sorts of ways, and others like thirteen impossible. Twelve became a noble, generous and familiar number to him and thirteen rather an outcast and disreputable one."

But only 3 of the 21 pamphlets were given to prehistoric times. The author is soon explaining in his provocative way the meaning of Egyptian, Greek and Roman civilizations. He criticises freely, whether it be Alexander, Caesar or the early Christian fathers. In fact the reader finds Alexander, Caesar, and later Napoleon compared with Mr. Wells and not always to their advantage. The Greeks are scolded for their failings in not applying science as we moderns have done, and for their petty jealousies and bickerings. "Dreaming souls, weary of the vulgarities of our time, have desired to be transferred to the sublime age of Pericles. But, plunged down into that Athens, they would have found themselves in very much the atmosphere of the lower sort of contemporary music hall, very much in the vein of our popular newspapers, the same hot blast of braying libel, foul imputation, greedy "patriotism," and general baseness would have blown upon them, the 'modern note' would have pursued them." To this provocative criticism Professor Gilbert Murray of Oxford, who is one of the authorities that have helped Mr. Wells by offering suggestions, objects because, as he says, the Greeks used their powers for intellectual and artistic things—"no more enormous works here to glorify divine kings, no private splendor, no luxury, but a wonderful output of art, poetry, philosophy, and—within limits—science. Compare them with Rome . . . . I can't help thinking that their badness was more like the faults of a superior South Sea Islander than like the viler side of the 'crowd' today. . . . The characteristic is that human thought got free."

Of the failure of the Roman empire, Mr. Wells writes: "The clue to all its failure lies in the absence of any free mental activity and any organization for the increase, development, and application of knowledge. It respected wealth and it despised science. It gave government to the rich, and imagined that wise men could be bought and bargained for in the slave markets when they were needed. It was, therefore, a colossally ignorant and unimaginative empire. It foresaw nothing."

Mr. Wells does not spare even "the seed of Christianity" from his searching criticism. "Jesus," he says, "was a penniless teacher, who wandered about the dusty, sun-bit country of Judea, living upon casual gifts of food . . . a figure . . . very human, very earnest and passionate, capable of swift anger, and teaching a new and simple and profound doctrine, namely, the universal Fatherhood of God and the coming of the Kingdom of Heaven." But, continues Mr. Wells, the idea of the Kingdom of Heaven proved too much for the established habits of mankind, and the hesitating disciples reverted "to the dear old habitual life of hates and profits and competition and pride."

Typical again is Mr. Wells' way of treating Mohammed, the founder of Islam. "Until he was 40 he did indeed live a particularly undistinguished life in Mecca, as the husband of a prosperous wife. . . . To anyone visiting Mecca about A. D. 600 he would probably have seen something of a loafer, a rather shy, good-looking individual, sitting about and listening to talk, a poor poet, and an altogether second-rate man." Though Mr. Wells concedes that the great Arab had much imaginative power, he describes him as a wary bargainer, insistent on safety first. At one time he publicly recanted his, at that time, radical teachings. But he no sooner had done so than he repented; "he said that the devil had possessed his tongue, and denounced idolatry again with renewed vigor."

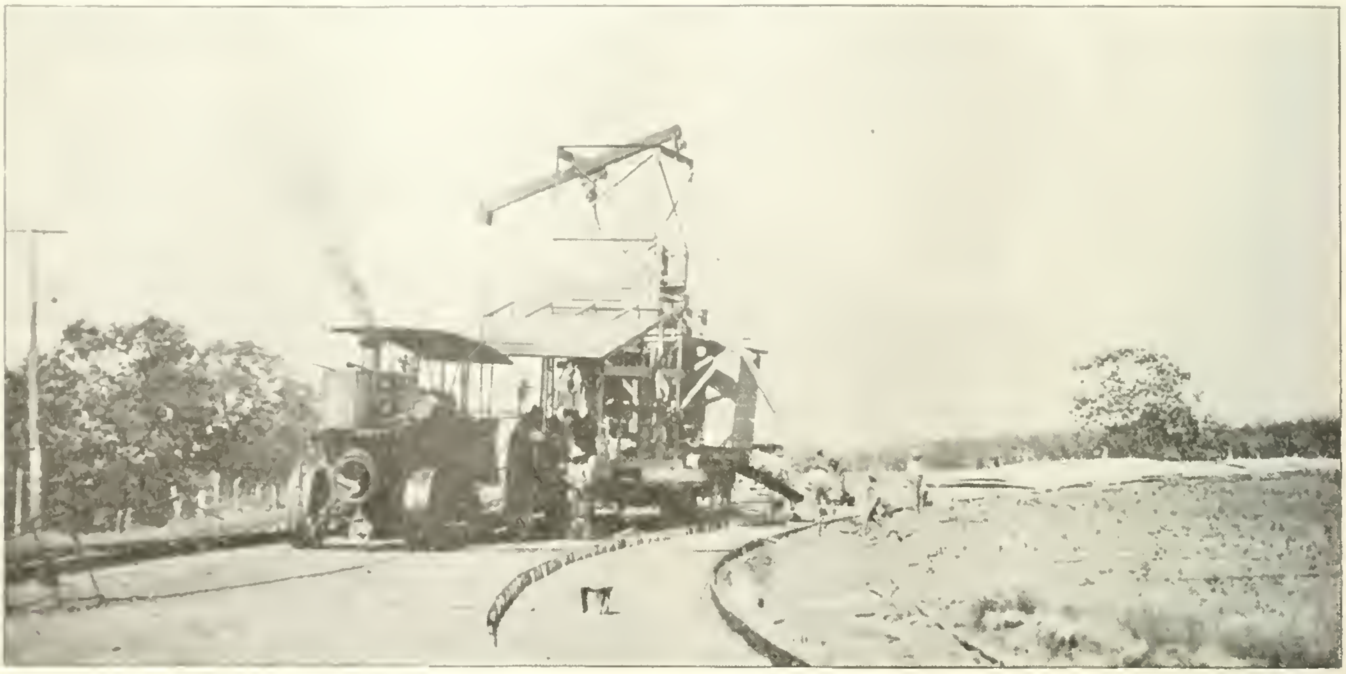
These extracts give an idea of Mr. Wells' bold and distinctly modern analysis of past ages. The style is one that should appeal to engineers, who are usually bored by the curiosity-killing methods of the traditional historians. If engineers wish to broaden their culture by reading, what book could be more appropriate than a history of the world interestingly put together by a man familiar with science and modern problems? What could be more enlightening to the engineer of today than to learn of the world in which Archimedes devised his machines, or to see how new ideas have been received during the ages; for human nature has changed very little for thousands of years.

Constructing 1072 Ft. of 18 Ft. Concrete Pavement in 10 Hours

By D. J. BLEIFUSS

What is believed to be a world's record for 1-course concrete paving was made Oct. 11, 1920, by Minnesota contractors on the Jefferson Highway, in Rice County, Minnesota, when they paved 1,072.6 lin. ft. of 18 ft. roadway in 10 hours and 21 minutes, mixer running time.

The contractors, Siems, Helmers & Schaffner, of St. Paul, Minn., have an industrial haulage system. The system comprises about 4 miles of 24 in. gage railway, two 6 ton gasoline locomotives, two steam locomotives, and about 30 cars, switch stands and accessories. The trains consisted, on the above date, of 16 cars each, with two wooden batch boxes to each car. The weight of one car, loaded, is from 3½ to 4 tons.

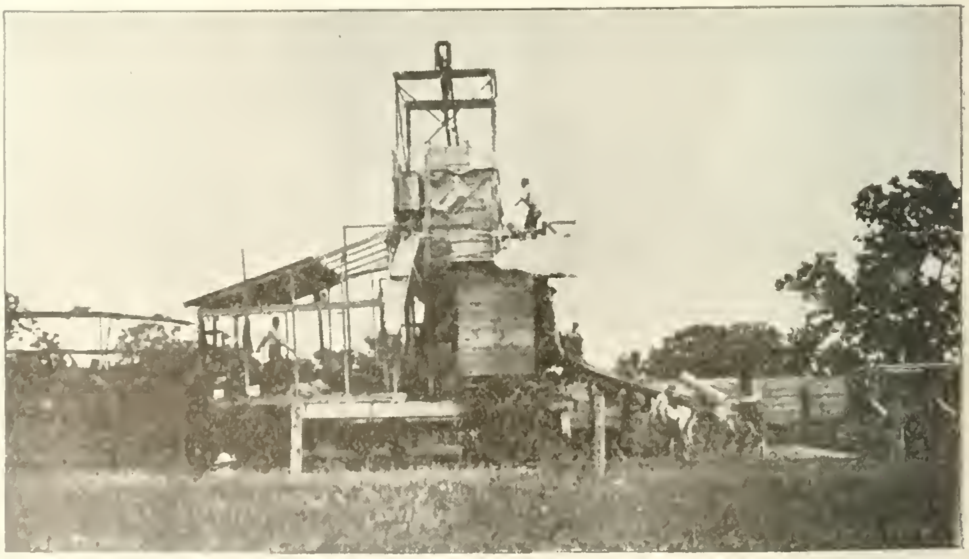


Mixing Plant Taking Curve North of Dundee.

As the road is graded to a width of 30 ft., shoulder to shoulder, there is ordinarily room for the track to be laid on the right side of the road, so that it will not interfere with the paving. In some cases, however, where the shoulder has slumped away a little, it is necessary to block up the track. Switches are kept as close as possible to the mixer without interfering too much with the form foreman. The haul on Oct. 11, on an average, was about 2,500 ft.

Sand and stone are loaded from hoppers, cement is dumped from sacks by hand. Sand and stone are proportioned by marks in the batch boxes, cement, of course, by sacks. The hoppers are filled from stock piles or directly from cars on the Great Western Ry. siding by a 1½ yd. clam shell.

Heltzel forms are used. A foreman is placed over the form setting, and the fine grading. Forms are set and lined before the subgrade is brought to an exact finish, being blocked up or dug down as necessary.



Mixer Mounted on Old Steam Shovel Base.

A Lakewood mixer is used. It is not a paver. It has been mounted on an old Marion steam shovel base, and a tower of structural steel built over it for hoisting the batch boxes. The base also carries the hoist engine used for this purpose. The whole is pulled by a 35 HP Minneapolis steam tractor, which supplies steam to both the hoist engine and the upright engine which turns the mixer. Water is supplied by a 2½-in. pipe line from a pump on the Cannon River.

The mix used is 1:2:4. Although rated at 4 bags of cement, the mixer is used with 5, and gives very good results. A width of 18 ft. is paved, 7½ in. thick at the center and 6½ in. at the edges. A ¾-in. rod is placed longitudinally 6 in. from each edge, and a ⅝-in. rod transversely every 12 ft. Two Lakewood finishers are used, one traveling about 50 ft. behind the other.

The contractors' organization follows:

OVERHEAD.

1 Superintendent.
1 Timekeeper.

MATERIAL YARD.

1 Yard foreman
2 Loaders at hoppers, dumping sand and stone.
4 Laborers, loading cement. On Oct. 11 they unloaded two cars of cement besides.
1 Hoist engineer } 1½-yd. clam-shell filling hoppers.
1 Fireman }
2 Laborers, in gondolas.

TRANSPORTATION.

1 Trainmaster.
2 Gas engineers.
2 Steam engineers.
4 Brakemen.

MIXER

1 Foreman
1 Hooker-on, who hooks the batch boxes to the hoist, and who is assisted by the brakeman of the train.
1 Dumper, who dumps the boxes into the mixer.
1 Mixer, who has charge of the water [illegible].
1 Spout man, on the distributing spout.
4 Laborers, spaders.
1 Laborer, does nothing but handle and place the reinforcement.
1 Handy man, watches water line, [illegible].
1 Tractor engineer.
1 Hoist engineer.
1 Template man, who runs a template over the subgrade [illegible] behind the mixer, and corrects [illegible].
2 Men running finishing machines.
1 Pump man.

FINE GRADING AND FORM SETTING

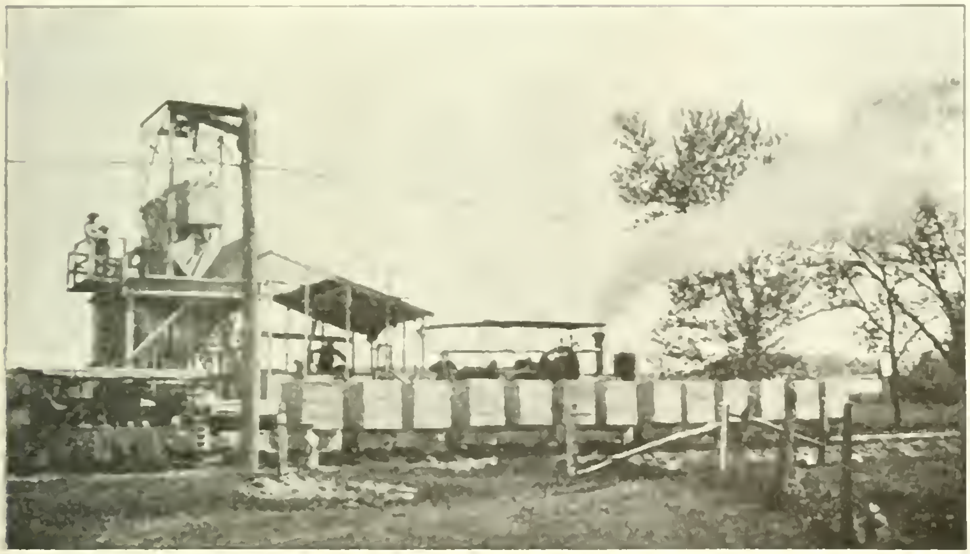
1 Foreman.
4 Form setters.
6 Laborers, hand surfacing.
2 Teams, grading.
1 Team, hauling up forms.
[illegible] Teamsters.
1 Man, cleaning and oiling forms.

MAINTENANCE AND REPAIR

1 Section foreman, on track.
3 Laborers, section gang.
1 Master mechanic.
1 Mechanic's helper.

MISCELLANEOUS

1 Watchman.
2 Truck drivers.



Dumping Batch Box Into Mixer.

On the day the record was made, mixing began at 6:15 a. m., and stopped at 5:36 p. m. Thirty minutes was taken for dinner, and there were two breakdowns causing a total delay of 30 minutes.

The superintendent of construction is Mr. Ryan, and the mixer foreman, E. Racy. The work is being done in conformation with the specifications of the Minnesota State Highway Department, and is under the direct supervision of Mr. P. L. Hazard, County Highway Engineer.

Cost of Maintaining Michigan Trunk Line Highway.—From May 1st to Dec. 31st, 1919, the state of Michigan participated in the maintenance of 4,878.08 miles of trunk line and Federal Aid roads at a total cost of $1,263,746.37. The average maintenance costs per mile, exclusive of supervision and equipment charges, were as follows:

Type.	Miles	Average cost per mile
Earth	[illegible]	[illegible]
Gravel	[illegible]	[illegible]
Macadam	[illegible]	[illegible]
Concrete	[illegible]	[illegible]
Not classified	[illegible]	[illegible]
Totals	[illegible]	[illegible]
Supervision		[illegible]
Equipment		[illegible]
Total		[illegible]

The above figures are taken from a paper presented at the recent State Good Roads Convention by Mr. G. C. Dillman, Maintenance Engineer, State Highway Department.

Roadway Widths for Different Classes of Streets

The determination of roadway widths is not a matter susceptible of exact scientific treatment; [illegible] general rather indeterminate facts enter into it. Therefore certain rules have been used by some engineers in fixing roadway widths, which while permitting an appearance of consistency in their work, after all, expressed only their judgment. Under similar conditions other engineers equally capable might not have considered such rules applicable. The subject of roadway widths has been widely discussed and quite fully treated by engineers. Not much that is new can be added. Yet a review of the situation seems warranted, especially as affected by motor driven vehicles. Such a review is given by Mr. Robert Hoffmann, Commissioner and Chief Engineer of the Division of Engineering and Construction of Cleveland, O., in a paper presented Oct. 15 at the convention of the American Society for Municipal Improvements. The following is an abstract of the paper.

Two Viewpoints in Determination of Roadway Widths.—The determination of roadway widths may be considered from two different points of view. One is from the viewpoint of appearance, governed by rules of proportion, or by making provision for predetermined widths of sidewalk strips or for lawn and parking spaces. The other viewpoint is that of traffic accommodation.

The first viewpoint applies principally to parkways, boulevards and certain classes of residence streets, where beauty and proportion largely control the design rather than economy and utility. Making the roadway from 50 to 60 per cent of the street width between property lines will, in many cases, satisfactorily suit conditions. The design of the planting strips and lawns will, however, nearly always control the width and arrangement of the paved roadways. Even here the expected traffic should receive consideration, but its subordination to other conditions may be perfectly logical and free from criticism.

Consideration of roadway widths from the second viewpoint, that of traffic accommodation, obviously applies to the greater number of cases, and should be the prevailing point of view when considering any basis of design or the standardization of widths.

Financial Side of Roadway Widths.—To justify the importance of the subject of roadway widths, it is only necessary to consider the financial side involved. Should the road building programs that are now being advocated be brought to the point of construction, it does not seem impossible that for some time to come 10,000 miles of pavement will be constructed yearly. An extra foot in roadway widths involves an expenditure of from $2,000 to $3,000 per mile of pavement under present conditions. For this country's entire road building project, therefore, a sum of from $20,000,000 to $30,000,000 becomes annually involved in the addition or rejection of a single foot of roadway width. This represents waste if the extra foot in width is unnecessary and means ultimate economy, if the additional foot will be required by traffic.

Not only is the unproductive investment, caused by an excessive width of roadway, to be deprecated, but, even more so, is the unnecessary removal of labor and material from useful application elsewhere to be regretted. On the other hand too small a width of roadway may result in slowing down the speed of traffic, in causing accidents due to collision or by vehicles being forced off the pavements and in bringing about a general curtailment of the usefulness of the highway. This condition creates a somewhat intangible damage and monetary loss that may far offset an apparent economy in initial investment.

Relation of Traffic to Width of Road.—The amount and character of traffic bear an important relation to the width of a road. The total tonnage for a given time or the weight of individual vehicles are of comparatively little importance when fixing the width, as the controlling factors are the size of the vehicles, the speed with which they are to be driven, and the lateral space which must be provided for passing vehicles.

Passenger vehicles as a class may be assumed to have a maximum overall width of 6 ft., while trucks and vehicles, normally used for carrying freight or merchandise over highways, do not generally exceed 8 ft. in width. However, there seems to be a natural tendency towards increasing the width of trucks especially for certain classes of merchandise, which has resulted in a number of places in limiting the size of vehicles by law. So far the maximum width of 8 ft. seems to satisfy existing conditions. The speed of the vehicles affects the clearance which should be left between vehicles when meeting or passing each other. Obviously fast moving cars require a greater clearance for safety than slow ones. Passenger cars consequently should be provided with greater clearance than slow running trucks. A provision of 10 ft. in width as the allotted space for each moving vehicle seems adequate for all cases, provided the maximum width of trucks does not exceed 8 ft. This unit width is larger than was formerly assumed in roadway design, but seems justifiable in the interest of safety. Many country highways, providing for two lines of vehicles, have been built narrower than the 10-ft. unit would require, and have served their purpose admirably. Such roadways have been constructed of widths varying from 12 to 18 ft. and when used principally for a moderate number of passenger vehicles have proven quite satisfactory. As the amount of traffic has increased, however, and the number of trucks using the highways has grown, it has been found necessary in many cases to widen the paved roadway in the interests of safety and the expedition of the traffic.

The length of the vehicle as it affects roadway widths is less important except in cases where the use of the vehicle requires its backing to the side of the road in order to load or unload. Many trucks are 25 ft. in length and become a determining feature if their use necessitates backing up to the curb or the side of the traveled roadway.

The kind of load to be carried may also have an influence on the practical width as frequently with light produce or other material, the load is built up so that it extends over the sides of the vehicle. Similarly, occasional loads extend over the back of the vehicle, as in cases of building material. The frequency with which these exceptional cases occur must be considered and may form a determining feature in certain cases.

Should a roadway be restricted for the use of one line of vehicles only, then the 10-ft. unit could be somewhat reduced. In such case the width need be only such as would accommodate the wheel base with a sufficient allowance to cover the irregularities in steering or driving. Probably 8 ft. in width would suffice. Cases of this kind will seldom occur on public highways and so narrow a roadway would not be justified unless the earth at the side furnished, under normal conditions, a usable road.

On light traffic roads and where the utmost economy must be practiced the single width roadway may be justified, but generally it will be found that the minimum width of paved roadway acceptable to traffic, must provide for two lines of vehicles, and should preferably be built 20 ft. in width. Here again this assumption can be modified and the width reduced to as little as 16 ft. when the natural soil conditions are favorable and admit of an occasional driving off the pavement where forced to do so by some passing vehicle.

For average conditions of traffic, the use of a 10-ft. space for each line of moving vehicles, is suggested as a unit of design. This width applies to street railway cars as well as other motor vehicles. Similarly 7½ ft. may be assumed as the required space for a row of standing vehicles, as when parked along and parallel with the sides of the road.

In fixing roadway widths upon the foregoing basis, the problem lies in assuming the probable number of lines of moving and standing vehicles which must be provided for. Considerable judgment will be required in making such an assumption. The growth of traffic is an element which must be considered and for which no exact data can be obtained. It is well known that the improving of a road by proper alignment, easy grades, and a smooth surface invites traffic, bringing to such road a far greater number of vehicles than had previously driven over it. With the improvement of the road it will usually be found that new buildings for homes or industrial uses will be located along the roadway, bringing with them added traffic in trucks and passenger vehicles. Many occasions will be found for stopping vehicles and allowing them to stand along the way. Should the stopping of vehicles be sufficient to warrant it, an added width must be assumed to provide for the necessary line of standing vehicles. This constantly changing character and extent of use to which a roadway is subject will always make difficult the adoption of the assumption needed for the economical design of roadway width.

Suggested Classification for Roadway Widths. In a general way the following classifications may be suggested as a statement of roadway widths in accordance with the foregoing discussion.

(A) **City Streets Having Double Street Car Tracks.**

1. Roadway 75 or 80 ft. in width. A roadway of such width will accommodate on each half, one line of street cars, two lines of moving traffic and one line of standing vehicles; or one line of street cars and three lines of moving traffic. In the latter case the 80-ft. width is preferable. The distance between property lines should be from 106 to 120 ft.
2. Roadway 55 or 60 ft. in width. A roadway of such width will accommodate on each half, one line of street cars, one line of moving traffic, and one line of standing vehicles, or one line of street cars and two lines of moving traffic. In the latter case the 60-ft. width is preferable. The distance between property lines should be from 80 to 100 ft.
3. Roadway 40 ft. in width. A roadway of such width will accommodate on each half one line of street cars and one line of either moving traffic or standing vehicles. The distance between property lines should be at least 60 ft.

(B) **City Streets Having No Street Car Tracks.**

1. Roadway 40, 55 or 60 ft. in width. Same condition as for streets having street car tracks, except that line of street cars is replaced by line of moving vehicles. Absence of street car tracks will frequently permit traffic going in one direction to occupy more than half the roadway. This would be possible when traffic is periodically greater in one direction than the other.
3. Roadway 20 to 35 ft. in width. Residence streets: A roadway of such width will accommodate two to four lines of traffic under different combinations of moving and standing vehicles. The distance between property lines should be 40 to 60 ft.

(C) **Highways Outside of Cities.**

1. Roadway 40 or 55 ft. in width. For traffic between important centers of population. A roadway of such width will accommodate four to six lines of traffic under different combinations of moving and standing vehicles.
2. Roadway 30 to 40 ft. in width. For traffic between centers of population of less importance than the foregoing. A roadway of such width will accommodate three or four lines of traffic under different combinations of moving and standing vehicles.
3. Roadway 20 to 30 ft. in width. For traffic between cities and smaller places or between important smaller cities. A roadway of such width will accommodate two or three lines of traffic under different combinations of moving and standing vehicles.
4. Roadway 16 to 20 ft. in width. Rural highways: A roadway of such width will accommodate two lines of traffic.
5. Roadways 8 to 10 ft. in width. Light country traffic where earth at side can be used to a limited extent.

(D) **Streets in Small Towns and Villages.**

1. Same classification as in cities, except that additional width may be required for standing vehicles where business is concentrated on few streets, so as to permit parking perpendicular or at an angle to the curb. Twenty to twenty-five feet for each row of standing vehicles will be desirable in this case.

The foregoing classification must of course be considered somewhat elastic and must be changed accordingly if cars are allowed to park otherwise than parallel with the curb. The question of parking cars upon public streets has an important bearing on the question of roadway widths as it also has upon the control of traffic in general. It must be decided which streets, if any, shall be used for the storage of cars. If the standing of vehicles on the streets is permitted for intervals of possibly longer than an hour, it becomes a problem of storage, and it may be necessary to so design the roadway widths that the greatest number of cars may be accommodated within a limited district. This may require provision for standing cars at an angle to the curb.

The importance of parking regulations entitles it to special consideration and it will not be further touched upon herein except to note that the adoption of a policy in connection with the parking of vehicles must necessarily have a bearing on the proper widths of roadways.

Pole and Concrete Track Roads for Logging

Two general types of roads which seem to be in general favor with the experienced loggers in the Northwest for the transportation of logs by motor truck in logging operations are described by Mr. W. H. Chapin in the October issue of Power Wagon. One of these is a pole road, the other is a concrete track road. The subgrade may be alike for each type of road. The grades may be left steeper for concrete, which affords better traction than poles. It is not advisable to have a grade steeper than 6 per cent where poles are used, while trucks will haul up a 12 per cent grade on concrete, and down a 15 per cent grade. The average width of a logging truck, measured outside the wheels, is 7 ft. 6 in. This calls for a road about 8 ft. wide, so the subgrade should be made about 12 ft. in width. Ditches for draining should be made and the water carried away from the hill side of the grade at least every 50 ft.

The best type of pole road is made with heavy single poles for the main tracks, lighter poles on the outside for guard rails and light poles on the inside to help support the steering-wheel. This makes three poles for each track, or six poles in all. The main pole should be about 20 in. in diameter. The longer these poles, the more serviceable they will be. The top side of the pole will be hewn down to a flat surface from 16 to 18 in. wide. This pole should then be laid in a ditch about 8 in. deep, leaving it half buried. It will be necessary to let the poles rest on cross ties about every 10 ft., also to spike them down securely to prevent them from rolling. The outside guard-rail should be about 8 in. in diameter or larger. This guard-rail is laid on the surface of the ground, close to the main pole. It should be well braced from the outside and securely spiked to the larger pole. With the main pole partly buried, the guard-rail will extend from 4 to 6 in. above ground. It is quite necessary to have this guard-rail when operating with a trailer. The inside pole should be the same size as the guard-rail, but the top surface must be hewn flat, and laid level with the main tracks. The inside surface of this pole should be smoothed up so as to lie close to the main pole. It will be an easy matter to brace these poles from the inside. The guard-rails have a braking effect by rubbing against the truck wheels.

After the poles are laid, the subgrade should be ditched in the center deep enough to carry away the water that falls in the middle of the road. The dirt from this ditch can be used to bank up the outside of the grade. The success of log hauling depends principally upon the road, and the success of the road depends upon the drainage.

Another form of pole road uses planks, 4 by 6 in., instead of poles, and has cross ties about 4 ft. apart. Both types of road are easily moved and can be used over and over again.

Two tracks of concrete—one for each wheel—are used in the concrete road. The ditches holding this concrete should be 6 in. deep and 26 in. wide. They may be filled to the top. A form should be in place so as to run a guard-lip 4 in. wide and 4 in. high on the outside top of the main surface. This will leave an inside surface 22 in. wide for the truck to run upon. The subgrade for the concrete road should also be well ditched in the center, having cross ditches every 50 ft., the same as recommended by the pole road.

The respective costs of the two types of roads depend upon the accessibility of the material. A concrete road of this type can be built for about $4,000 per mile. This does not include the grading. The cost of the pole road will probably be about $3,000 per mile.

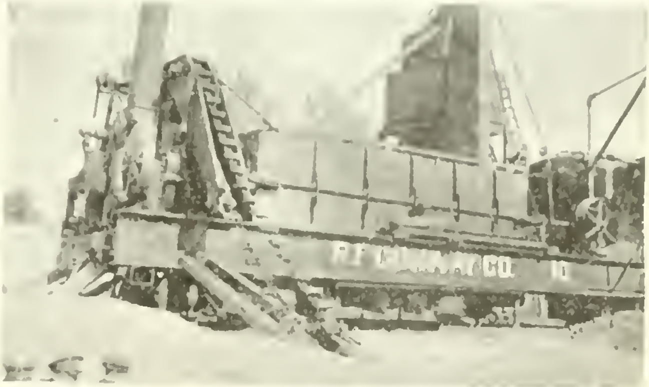
Recent Asphaltic Pavement Construction on Illinois State Highway and Chicago Boulevard Link*

By JOHN B. HITTELL,

District Engineer of The Asphalt Association

For purposes of comparison and perhaps future study it was thought of possible interest to present a brief description of two asphaltic types of construction recently designed and constructed or under construction and each of which will have, according to belief, a large amount of traffic. While there is nothing exceptionally distinct in the designs from the usual, yet in one case a rather unusually rich mix was used in the cement foundation, and in the other an attempt was made to secure a "stiff" top mixture.

The highway is suburban with unrestricted traffic of unknown amount and sparsely policed; the other is metropolitan with restricted but intense traffic, which at times is all it can carry. Asphaltic concrete and sheet asphalt with binder courses of equal thickness are placed against each other and future study may throw some important light on the relative value of these paving surfaces.



Mixing Plant for Asphaltic Binder and Top.

Asphaltic Concrete on Chicago, Waukegan and Milwaukee Road. In 1919 bids were called by the Illinois State Highway Department for Sections A, B, C and D of Project 4, Federal Aid, on what is known as the Chicago, Waukegan and Milwaukee road, lying in Cook and Lake counties—roughly 3 miles in the former and 17 miles in the latter. The R. F. Conway Co., of Chicago, a firm of ample capital and large experience in the construction of all classes of street pavements, and successful in completing several concrete road contracts with the department, was awarded the contracts on Sections A and B for asphaltic concrete and C and D for cement concrete. The asphalt bids were about $7,200 per mile greater than those for cement concrete. Undoubtedly the authorities in charge desired to avail themselves of an opportunity to make a fair comparison between bituminous and cement concrete highway construction, as the conditions were ideal: the same soil, traffic, widths of roadway, a thoroughly equipped and experienced contractor, and the fact that the asphalt would connect at each end with a cement road.

As its name implies, the project, when completed, will furnish a road connecting the manufacturing cities of Chicago, Waukegan and Milwaukee, and very likely is destined to a heavy traffic.

Section A at the south end of the job, comprises 48,507 sq. yd. of pavement, and Section B, which is contiguous, comprises 36,929 sq. yd., and jointly extend a distance of almost eight miles.

The road commences at the village of Techny and runs northwesterly through the villages of Shermerville, Deerfield and Everett. At Techny it connects with a cement concrete road which is 18 ft. in width, 7 in. in thickness at the sides and 8 in. in the center; mix, 1:2:3½.

The road extends through typical Illinois farming country and in part was an old macadam highway, with the exception of a stretch of about three miles running from Deerfield to

---

*Abstract of a paper presented last month at the convention of the American Society for Municipal Improvements.

Everett, which is a new location through [illegible] lands. The old macadam was of varying widths and in all instances less than that of the finished road, and on account of the cut is practically of no material value as a support for the pavement. The soil throughout is of clay and drainage is similar to that of other roads built in the state consisting of side ditches, cross culverts, etc.

During the process of grading long stretches of light cutting were encountered and to facilitate this a large Koehring grader was employed, with the result that the operations at times reached the point where 3-yd. wagons were loaded at the rate of 75 per hour. At the end of one of the cuts where a [illegible]-ft. fill was made the soil was such that horses mired themselves and were unable to move their loads. This was overcome successfully by employing a large caterpillar tractor to which were attached three wagons.

Roughened Concrete for Binder Course, Chicago, Waukegan & Milwaukee Road.

Concrete for Base Hauled 2½ Miles.—In the first part of 1920 a central mixing plant, consisting of two 4-bag mixers, was installed for mixing concrete, which was then hauled in trucks for a distance of 2½ miles and deposited on the grade. This system proved successful during the early stages of the work but had to be abandoned later owing to the inability of the material producers to supply the quantity of materials necessary to operate the mixers simultaneously.

The materials for the concrete are hauled in special bodies mounted on a Ford chassis, a body being sufficiently large to contain one batch of 4 bags of cement, sand, and stone in the proportions of 1:2:3½. The truck is first loaded with 4 bags of cement from the pile or car, then to the sand car where the sand has been previously shoveled into a box attached to the side of the car from which it is emptied into the truck. This box is readily moved from one point to another on the side of the car, and is sized to hold twice the portion of cement. The necessary amount of coarse aggregate is added and is gaged by the size of the body. About twenty-five of these trucks are employed, and being equipped with 4½-in. tires on the rear wheels, very materially help to compact the subgrade. In fact the District Engineer of the State Highway Department advised me that there is practically no rolling of the fine grade. The line and grade is maintained by steel forms and exact sub-grade secured by a strike board drawn along the same. The condition of the sub-grade is excellent.

The concrete is 6 in. at the sides and 7 in. at the center and the difference makes the crown for the finished pavement. On tangent lines the subgrade is flat. The state 1920 specifications call for cement concrete pavements to be uniformly 8 in. in thickness with a crowned subgrade, and 7-in. foundation for bituminous pavements.

On curves the superelevation is as follows, the width being 18 feet.

	In
6° 30'	15
6	13¾
5 30	12¾
5	11¼
4 30	10¼
4	8¾
3 30	7¾
3	5¾
2 30	4⅞
2	3½

The rise on curves of 7 degrees (about 800 ft. radius) or less, is 1 in. per foot of width.

The maximum gradient is not over 3 per cent. except at bridge approaches, where it is 4½ per cent.

Curb and Method of Roughening Concrete Surface.—In the specifications originally no curb was provided for the bituminous surface, but wisely through an agreement between the contractor and officials a curb 4 in. in width and about 3 in. in height is being built integrally with the foundation. The height is a trifle less than 3 in. in order that the wearing course may be thoroughly compacted at the edge of the curb.

The average progress of the concrete foundation with curbing is over 400 ft. per day. Last fall when the work was first started brooms were used to roughen the surface of the concrete, but this method was very shortly superceded by a hand roller. This roller was designed by Mr. G. N. Lamb, District Engineer of the State Highway Department and consists essentially of 5 ft. 10-in. wrought iron pipe sealed at both ends, to which has been attached at intervals of 5 in. ordinary 1-in. angle irons. The roller is operated by two men, one on each side of the roadway, and corrugations are made roughly at an angle of about 60 degrees both to the right and left of the center line of the road, leaving the surface roughly "diamond" shaped. The result is very satisfactory. Curing of the concrete is secured by the use of wetted tarpaulins and flooding afterwards. No earth is used for this purpose as it is not considered possible to remove it afterwards from the rough concrete in a satisfactory manner.

In all 4,000 ft. of finished roadway was laid in 1919, the concrete was started on Sept. 24th, while the binder and top was laid during the week of Nov. 20th. Owing to the lateness of the season the contractor ran these materials from his Elston avenue plant, in Chicago, hauling it in 7½-ton trucks a distance of 17 miles. The penetration varied between 56 and 58. Inspection was had by the state at the plant, on the work and by its laboratory at Springfield.

To finish this year more than 7 miles of binder and top the contractor has installed at Deerfield a 1-car Cummer plant of capacity of approximately 200 tons or 700 lin. ft. of completed bituminous work. The haul will average two miles. Two tanks of about 18,000 gal. capacity, one for fuel oil and one for asphalt cement, will be used to guard against intermittent supply of these materials.

Characteristics of Asphalt Used.—The specifications gave the bidder the latitude of selecting an asphalt of any of the well known brands as well as tar for the bituminous cement, and the option of bidding with or without a binder course. He chose the binder course and bid on an asphalt meeting the following requirements:

Chicago, Waukegan & Milwaukee Road Near Techny, Ill.; Note Curb Protecting Asphaltic Surface.

Specific gravity 25° C./25° C. (77° F.)	1.020 to 1.060
Flash point	Not less than 177°C. (350°F.)
Ductility at 25° C. (77° F.)	Not less than 100 cm.
Penetration at 25° C. (77° F.), 100 gm., 5 sec.	55 to 75
Loss at 163° C. (325° F.) 5 hours	Not over 2.0%
Penetration of residue at 25° C. (77° F.), 100 gm., 5 sec.	Not less than 30
Total bitumen	Not less than 99.5%
Per cent of total bitumen insoluble in 86° B. naphtha	15.0 to 29.0
Fixed carbon	9.0% to 17.0%

The mixer for [illegible] course [illegible] of asphaltic cement or tar, stone chips and [illegible]. The materials shall be so combined that the mixture [illegible] average proportions by weight as follows:

Bitumen	[illegible] to [illegible]
Mineral passing 10 mesh	[illegible] to [illegible]
Mineral passing 2 mesh and retained [illegible]	[illegible] to [illegible]
Mineral passing 1 mesh and retained [illegible]	1 to [illegible]

The mixture for the wearing course [illegible] of coarse aggregate, fine aggregate, filler and [illegible] or tar. The materials shall be so combined that [illegible] contain average proportions by weight as [illegible]:

Bitumen	[illegible] to [illegible]
Mineral passing 200 mesh	[illegible] to 10%
Mineral passing 40 mesh and retained [illegible]	20 to 30%
Mineral passing 10 mesh and retained [illegible]	[illegible] to [illegible]
Mineral passing 4 mesh and retained [illegible]	[illegible] to 22%
Mineral passing 2 mesh and retained [illegible]	0 to 10%
Mineral passing 2 mesh and retained on 10 mesh	18 to 32%

No guarantee is required.

The construction of this asphaltic road and the connecting cement road by the same contractor, and under conditions as equal as can be had, will give an exceptional and excellent opportunity for the observation of the effect which different factors have upon the life and service of a pavement. Many engineers believe that this foundation is needlessly expensive.

Traffic Notes.—The beginning of the road is 19 miles from the city hall in Chicago. On Sunday, Aug. 8th, and Monday following, Mr. Geo. A. Quinlan, Cook County Superintendent of Highways, took a count of the traffic on Milwaukee avenue, between Dempster street and Ballard road, a point located 15 miles from the city hall. The results showed that 11,991 motor vehicles traversed the road on that Sunday. The Monday count gave a total of 2,721 motor vehicles.

The percentage of motor trucks of all vehicles was 5 on Sunday and 10 plus on Monday. Neither of these days of the week was probably as good as any of the remaining five to ascertain the amount of truckage since business is generally suspended on Sunday. Deliveries are usually from the city on Monday's orders, and farm produce is seldom loaded on Sunday for Monday delivery. Trucks to all motor vehicles is 12.6 per cent in the state and 20.1 per cent in Chicago.

The County Superintendent of Highways has a force of about twelve men who are assigned to patrol about 200 miles of the most important improved highways in Cook county.

Sheet Asphalt on Boulevard Link, Chicago.—The paving specifications were: Concrete base 8 in. in thickness, mixed in proportion of 1:3:6. Binder course 1½ in. in thickness, composed of stone varying in size from 1 in. downwards, sand and bitumen, resulting in mixture containing 4 to 7 per cent of bitumen, and from 20 to 30 per cent of material passing a 10-mesh screen.

The surface mixture and a test of one batch are as follows:

	Specifications.	Test	Composition
Bitumen	10-12	10.5	Trinidad 76%
Portland cement and mineral matter passing 200 mesh sieve.	15-20	18.0	
Sand passing 80 mesh sieve	20-30	21.6	I. R. C. 24%
Sand passing 40	20-40	38.2	Penetration 40
Sand passing 10	8-20	10.5	
Sand passing 4	5-10	1.2	

The gradient on the approaches is under 2 per cent and most of the work is on a level grade. On level stretches the crown on the 80-ft. roadway is 10 in. with a parabolic curve; on gradients this was reduced to 9 inches. The reasons for these flat surfaces probably were to accommodate traffic comfortably near the curb lines, coupled with the assurance that these roadways being boulevards would be kept clean.

The improvement was made solely to accommodate pleasure car traffic between the two sides of the river and to provide separate roadways for commercial traffic to and from the railroad freight yards.

Traffic on Boulevard Link.—The number of cars is very large and during the rush hours of the morning and evening the entire roadway is covered. Speeds of 25 and 30 miles per hour are common at these times and are not opposed by the officers policing the road.

The Chicago Motor Bus Co. operates a line of busses of two types weighing empty 10,500 and 11,500 lb., having an allowable ordinance capacity of 50 and 60 persons respectively. Application to use a type carrying 60 passengers and weighing 12,500 lb. has been made to the authorities and one of this class is now operating under temporary permit. By ordinance the schedule intervals, except at midnight, is not more than 20 min. "or satisfactory service." In fact the rush at morning and evening intervals is about two minutes and during the rest of the day ten minutes. The rate of speed ranges from 15 to 20 miles per hour. Genuine co-operation has prevailed among the company's officials and the authorities, with the result that the dest[illegible] on the traffic on the pavement has been redu[illegible].

An automobile count at [illegible] ft. north of Chicago avenue) and North Michigan [illegible] on Sunday, Feb. 29th, 1920, from 10 a. m. [illegible] motor vehicles. Another count at Lake Shore Drive (N. Michigan avenue) and Oak street (1,300 ft. north of [illegible] avenue), on Sunday, July 25th, 1920, from noon to [illegible] showed 12,700 motor vehicles.

The B. F. Goodrich Rubber Co. on Wednesday, Aug. 11, 1920, took a count of the traffic at Michigan avenue and Jackson boulevard, a point about six blocks south of Randolph street. The count lasted from 7 a. m. to 8 p. m. With the following results:

North-bound vehicles	18,112
South-bound vehicles	18,[illegible]
Average per hour	[illegible]
Average per minute	[illegible]

For data and information the writer is indebted to Mr. G. N. Lamb, District Engineer of the State Highway Department of Illinois, Mr. Geo. A. Quinlan, Superintendent of Highways, Cook county, Ill., and representatives of the R. F. Conway Co.

Method of Blasting Brule Clay in Road Grading

Grading for the Valentine-Sparks Federal Aid Highway in Cherry County, Nebraska, will necessitate the blasting of nearly 60,000 cu. yd. of material, according to the October monthly report of the Public Works Department of Nebraska. The soil is heavy Brule clay of a conglomerate mass without seams or fissures. It is much like chalk and exceptionally hard. Because of the nature of the soil, it was found necessary to use explosives to loosen the material in the cuts adjacent to the two Niobara River crossings, both for the purpose of loading the clay which is used for hard surfacing purposes, and also for the cuts in the roadway proper. It will be necessary to blast nearly 60,000 yd. of this material both for the roadway and for the surfacing from Valentine at the west end of the project to about 12 miles east. Holes are being drilled to the depth of the grade line where it does not exceed 8 to 10 ft. of cutting. This is then loaded, hauled, and spread in place. Where it is necessary to go deeper than this another set of drill holes is bored the required depth, and the holes again loaded. The blast holes are drilled about 8 ft. centers and black powder and T. N. T. (Tri-Nitro-Toluol) are used. It was found impossible to excavate the material by drag-line owing to the nature of the Brule clay. However, a dipper drag-line, capacity 1 yd., is used for loading the clay which has been loosened by blasting. Dump wagons pulled by tractors, as well as trucks are used for hauling and distributing it upon the prepared road. The tractors pull a train of 8 wagons, each loaded with from 2½ to 3 yd. of material; the truck's load is about the same capacity.

Oklahoma Engineers Active.—The annual meeting of the Oklahoma Society of Engineers at Tulsa, Okla., Oct. 26-27 by previous arrangement resolved itself into The State Engineering Council. The Oklahoma society had invited all the different engineering organizations in the state to send committees to consider jointly matters of legislation and to effect a permanent organization of the State Engineering Council, and this in turn is subdivided into a legislative committee and a ways and means committee. About 50 committee members were listed for attendance and fully 80 were in attendance. The licensing bill for professional engineers was fully agreed upon. The salary schedule for highway engineers, from the engineer of the smallest county up to the State Engineer, was agreed upon in full (the statutory pay of a county engineer at this time, except in three counties, is limited to $5 per day, and yet the county engineer has to pay his assistants $175 to $200 per month). A bill to strengthen the special assessment paving law was referred to counsel. The engineers recommended the construction of an engineering building at the State University to cost $500,000, and recommending the strengthening of the Engineering Department of the State Board of Health. The officers elected for the coming years are as follows: President, George J. Stein, Miami, Okla.; vice-presidents, V. V. Long, Oklahoma City; B. E. Clark, McAlester, Okla.; B. F. Lewis, Enid, Okla.; secretary-treasurer, Donald Witten, Tulsa, Okla.

Central Loading Plant and Haulage Methods for 6 Mile Concrete Road Job

Considerable saving in labor and material was effected by the Bickel Contracting Co., Kansas City, Mo., on a road paving job near Wichita, Kans., by the use of a central loading plant. The contract covered 6 miles of road with concrete base and brick top. The base is 7 in. thick at the center and [illegible] in. thick at the sides, with curb built integrally.

The sand, rock and cement are received by rail, unloaded into storage piles or bins by means of a clam shell bucket and discharged into automatic measuring chambers or bins.

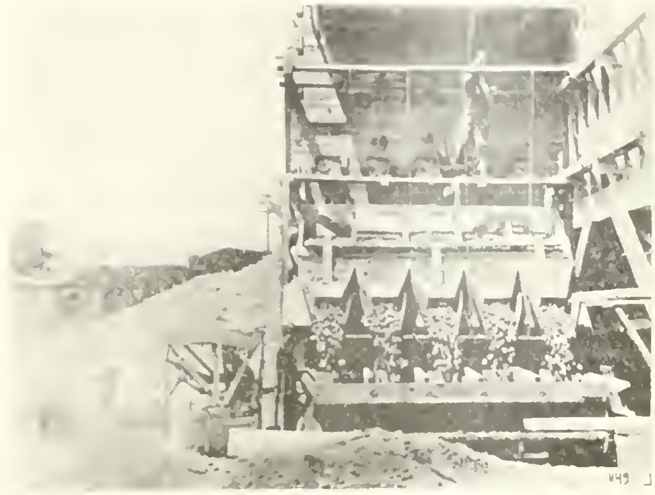


Fig. 1.—Rock Hoppers Discharging Into Compartment Body of Truck.

The rock and sand bins are each equipped with five measuring hoppers, the rock compartments holding 10 cu. ft. each and the sand compartments 6 cu. ft. each.

The operator at the rock bin pulls a lever which releases five spouts, thus charging at the same time the five rock measuring hoppers. When these have been filled the movement of a lever shuts off the rock supply and the hoppers are ready for discharge into compartment trucks. Five levers control the movement of sand from bin to measuring hoppers. These levers are controlled separately by the operator, but the dumping of the hoppers into compartment trucks is accomplished by the movement of one lever. Figure 1 shows the rock hoppers being discharged into the compartment bodies of truck, the flow of rock is uniform and the complete charge is delivered in less than one minute. After taking the rock charge the truck backs under the sand hoppers and the sand is loaded in about 15 seconds. The truck then moves forward 500 ft. to the cement storage building, where the cement is loaded in a manner similar to that of the rock. Figure 2 illustrates this. By this method the cement sacks are all kept at a central plant and the loss of both cement and sacks is reduced to a minimum. The rock and sand wastage is also reduced to a minimum, kept free from dirt, and each charge is accurately proportioned.

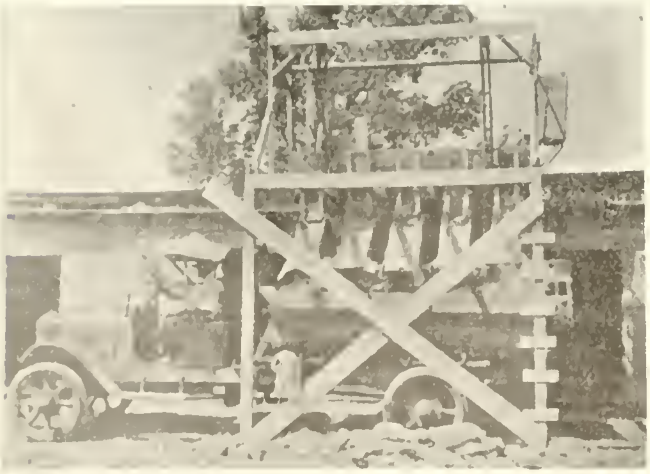


Fig. 2.—Arrangement for Loading Cement Into Truck Body.

Transportation involved a maximum one-way haul from loading bins to mixer, of 3 miles or a 6 mile round trip. The hauling was done with six $3\frac{1}{2}$-ton Republic trucks equipped with specially designed steel dump bodies partitioned into five independent compartments, each holding a complete mixer charge of rock, sand and cement.

The trucks are started from the loading plant on a regular schedule 7 minutes apart and travel toward the mixer at a speed not to exceed 12 miles per hour. In the meantime the mixer crew has set steel side forms, prepared for the subgrade, which is of a sandy character and necessitates the use of track (see Fig. 3) to keep the trucks from cutting it up. Moved and set 375 ft. from the Koehring boom and bucket mixer is a specially designed turntable which permits the turning of a truck in less than one minute, and is ready to receive the first load.

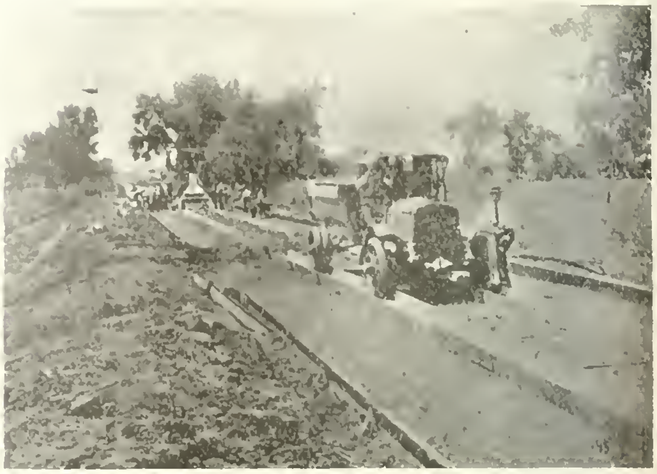


Fig. 3.—Track for Preventing Cutting of Subgrade.

The first truck to arrive enters the turntable (Fig. 4) and is turned around. The truck then backs toward the mixer on track and during this travel the body is hoisted to an angle of 45 degrees by a Wood hydraulic hoist and is in position to dump on its arrival at mixer.

After the first batch is dumped into the mixer hoist the truck moves forward 2 or 3 ft., then the mixer pan is hoisted and materials dumped into mixer. The pan is then lowered and the truck backs up and the second compartment is dumped. Each succeeding compartment is dumped in a similar manner. After the truck has completed its dump it goes forward to a point half way between mixer and turntable, where it leaves the track and passes out an opening in the forms as shown in Fig. 3.

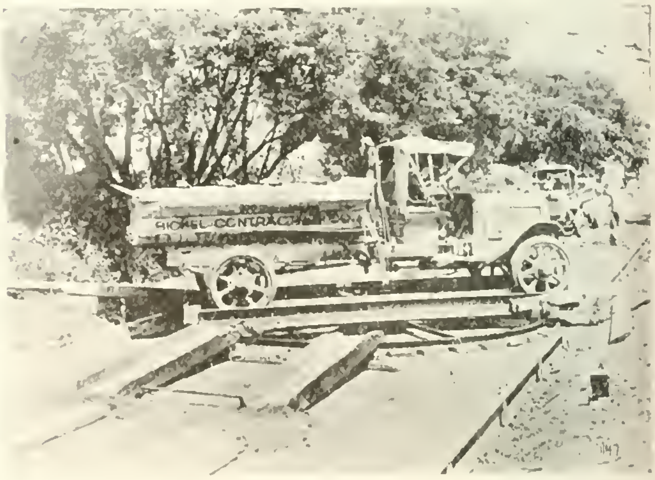


Fig. 4.—Specially Designed Turntable.

On the maximum haul the trucks made their round trip in

42 minutes traveled [illegible] miles each day and used gasoline at the rate of 3.75 miles per gallon [illegible] included the gasoline consumed by engines [illegible] time of loading, turning and discharge.

The trucks are operated by $5 a day drivers who have become skillful in maintaining their driving schedule. In order that there may be the minimum of breakdowns or delays in the transportation system, a completely equipped shop in charge of a competent mechanic is located at the loading plant and the trucks are given a thorough inspection and oiling each morning before starting their day's work.

The water supply is obtained by a duplicate set of pumps and engines which take water through driven sand points from the Arkansas River underflow and delivers it through a 2-in. line to mixer, roller, subgrade and pavement. Each pump handles 40 gal. per minute against 60 lb. pressure and one pump is always held in reserve. The pumps are moved and reset once each mile, thus making the maximum pumping ½ mile. Tees are inserted in the pipe line each 50 ft. and the pipe line is connected to the mixer by 50 ft. of 2 in. cotton, rubber lined, mill hose and the connection changed once each day. The average day's run has been about 600 sq. yd. of road.

The following details of the hauling operations are of interest:

Total investment, six 3½-ton trucks with [illegible] dump bodies and hoists	$27,720
Average mileage per gallon of gas	3.75
Average mileage per gallon of oil	75
Each truck makes a round trip in [illegible] minutes [illegible] delays.	
Each truck averages five trips per day.	
Average miles per day [illegible] or [illegible] miles loaded one way.	
Average total tons per day each truck	23.5
Average cost per day each truck, including driver, amount of depreciation, tires, labor, repairs and [illegible]	$2[illegible]
Average cost per ton haul	1.04
Average cost per mile haul	.366
Average cost per ton mile haul	.0815
Average cost per square yard of road	.219

The above figures are based on eight hours of labor per day and 300 working days in the year.

Development of Asphalt Blocks and Methods of Laying

A brief outline of the development of asphalt blocks as regards size and depth and method of laying was given by Mr. P. S. Thompson, Sales Manager, The Hastings Pavement Co., New York, in a paper presented at the recent convention of the American Society for Municipal Improvements. According to this paper, previous to 1897 the blocks were made 4 in. wide, 12 in. long and 5 in. deep, and were usually laid on a sand and gravel foundation. From 1897 to 1900 the size of the block was 4 in. wide, 12 in. long and 4 in. deep, and the method of laying was generally a concrete foundation and sand cushion. In 1900 the size of the block was again changed to 5 in. wide, 12 in. long and 3 in. deep, and it was about this time that the method of laying the blocks on a mortar bed, instead of a sand cushion, came into general use. Improvements in the methods of manufacture resulted in the successful production of a 5-in. x 12-in. by 2-in. (deep) block in 1908 and later of the 8-in. x 4-in. x 1¼-in. (deep) block. Following the perfection of the automatic hydraulic press and increased efficiency in manufacturing and laboratory methods constantly improving the quality of the block, the tendency has been to a rapidly increasing use of the thinner blocks. The 4-in. deep blocks are now obsolete, and the 5-in. x 12-in. x 3-in. (deep) block, although still manufactured for special uses, comprise less than 10 per cent of the total output of the block industry. The vast majority of the asphalt blocks now laid are 5-in. x 12-in. x 2-in. (deep) and 4-in. x 8-in. x 1¼-in. (deep). The latter bears the trade name of "eightfour," and has been extensively used on shop floors, loading platforms, traffic aisles, etc. Mr. Thompson states that there is no valid reason why the "eightfour" should not constitute an entirely satisfactory highway surface in a good many localities, and it is regarded as highly probable that in the near future the "eightfour" will be put to such use.

Convention of State Highway Officials.—A 4-day convention of the American Association of State Highway Officials will be held at Washington, D. C., December 6-10.

Pavement Foundations as a Factor in Economic Transportation*

By ROBERT [illegible] BARNETT

[illegible]

The purpose of this paper is to trace the connection between pavement foundations and the cost of transportation and to prepare the way for a determination of the critical relation that must obtain in order that such cost may become minimum.

The ultimate objective is economic transportation.

Pavement foundations are a part of the economic system. To properly correlate the part with the whole and therefore obtain a more complete knowledge of it, it is necessary to have in mind a concept of the whole. Hence, before discussing the part, a bird's-eye view, as it were, of the whole system is here presented.

ECONOMIC SYSTEM FOR HIGHWAY TRANSPORTATION

OBJECTIVE—

To produce transportation at [illegible]

$$\text{Unit cost} = \frac{\text{Annual Cost}}{\text{Annual Tonnage}}$$

Total Annual cost = Annual Cost of Roadbed + Annual Cost of Equipment + Annual Cost of Power.

Ton-mileage = Annual Tonnage × Distance Hauled.

$$T_a = \frac{NKHS}{L}$$

in which

T_a = annual tonnage.
N = number of vehicles.
K = capacity of vehicles in tons.
H = hours of work per annum.
S = average speed in miles per hour.
L = length of roadway in miles.

Characteristics of Roadbed:
Length—Width—Grade—Curvature—Bearing Capacity of Subgrade.

Characteristics of Equipment:
Number of Vehicles—Capacity—Weight—Weight of unsprung parts—Resiliency of springs and of tires.

Characteristics of Power Plant:
Efficiency of engine and transmission of gearing.

CLASSIFICATION OF COSTS.

- Annual Cost of Roadbed ......
  - 1. Interest on construction cost...
    - 1. Land for right of way.
    - 2. Clearing and grubbing.
    - 3. Grading.
    - 4. Paving.
    - 5. Bridges, culverts and drainage.
    - 6. Fences, signs, markers, safety gates, etc.
    - 7. Engineering and legal expense.
  - 2. Maintenance .....
    - 1. Repairs.
    - 2. Renewals.
  - 3. Administration.
  - 4. Amortization.
- Annual Cost of Equipment ...
  - 1. Interest on first cost.
  - 2. Licenses and taxes.
  - 3. Insurance.
  - 4. Administration.
  - 5. Amortization.
  - 6. Maintenance (Repairs and renewals).
  - 7. Garaging.
- Annual cost of Power ....
  - 1. Gasoline.
  - 2. Oil, grease and waste.
  - 3. Maintenance of power plant (Repairs and renewals).
  - 4. Drivers' salaries.

CONTRIBUTING FACTORS.

Fixed Factors:
1. Annual Tonnage, net.
2. Hours of work per annum.
3. Air line distance between termini.
4. Difference in altitude of termini.
5. Intervening Topography.
6. Bearing capacity of subgrade.

Variable Factors:
7. Excess distance.
8. Excess lift.
9. Resistance of pavement to wear.
10. Tractive resistance.
11. Load capacity of truck.
12. Resiliency of tires and springs.
13. Speed.
14. Efficiency of engine and transmission gearing.

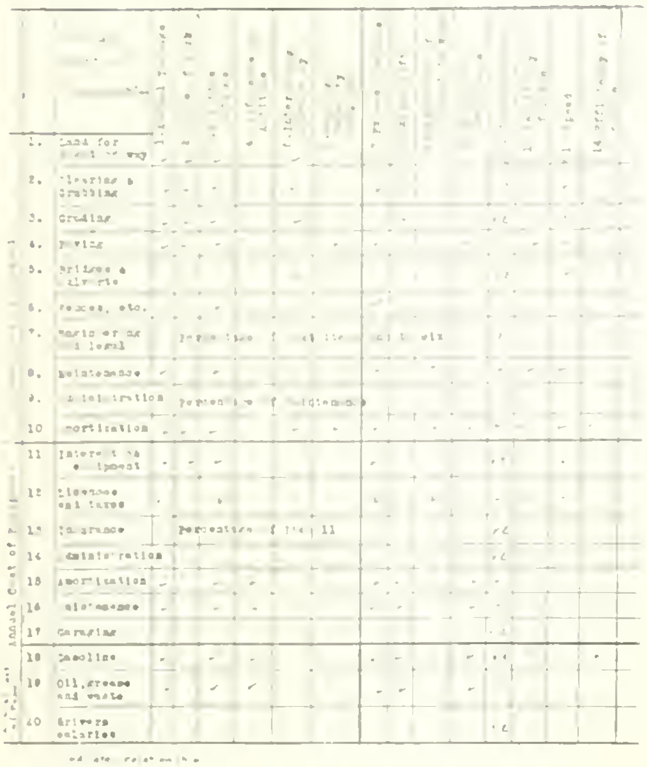
INTER RELATIONS AMONG FACTORS OR CRITERIA

1. Economic Excess Distance.
2. Economic Excess Lift.
3. Economic Truck Capacity.
4. Economic Resiliency.
5. Economic Speed.
6. Economic Tractive Resistance.
7. Economic Resistance of Pavement to Wear.
8. Economic Width of Pavement.
9. Economic Cut.

The foregoing outline indicates that pavement foundations affect the cost of pavements, and that the cost of pavements influences the cost of construction and the interest thereon.

---

*Abstract of a paper presented at the recent convention of the American Society for Municipal Improvements.



1.	Land for right of way	
2.	Clearing & Grubbing	
3.	Grading	
4.	Paving	
5.	Bridges & culverts	
6.	Fences, etc.	
7.	Engineering and legal	Percentage of cost items [illegible] to six
8.	Maintenance	
9.	Administration	Percentage of [illegible]
10	Amortization	
11	Interest on equipment	
12	Licenses and taxes	
13	Insurance	Percentage of item 11
14	Administration	
15	Amortization	
16	Maintenance	
17	Garaging	
18	Gasoline	
19	Oil, grease and waste	
20	Drivers salaries	

Quantitative Relation of Factors to Cost Items.

which in turn affects the annual cost of roadbed, and through this the annual cost of transportation. Although essential to progress, the realization of this sequence of connections is only a bare beginning towards solving the problem of attaining economic transportation. There is further needed a determination of the quantitative effect of one factor upon the other. In the end there must be formulated an expression of the several relations. To develop such an expression, it is necessary to analyze the series of connections in much detail. As a preliminary to this a brief resume of the available data is desirable.

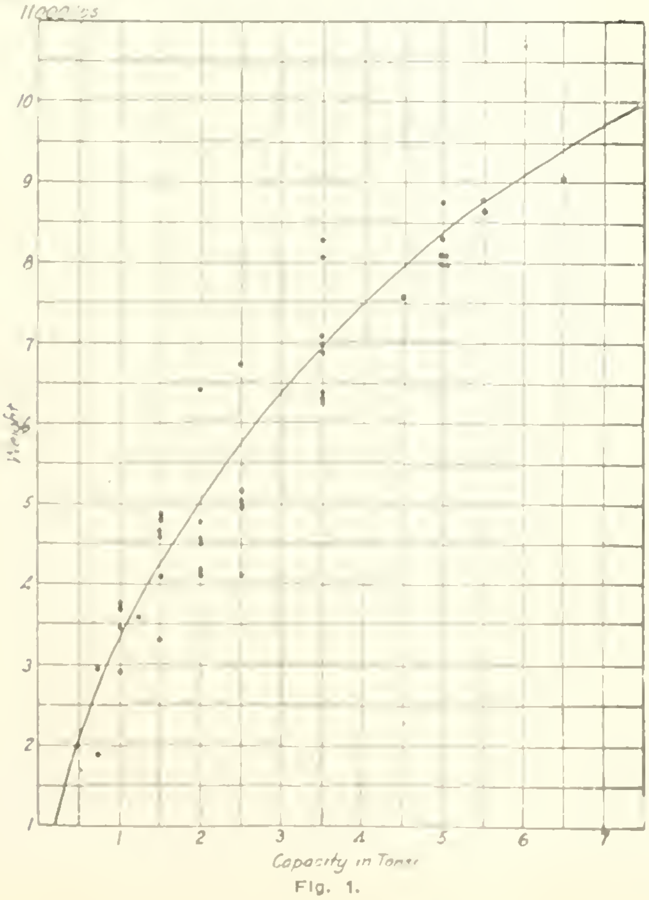


Fig. 1.

Relation Between Thickness of Foundation and Wheel Load.—First, we have the vehicle at rest with the loaded wheels bearing on comparatively small areas of the road surface, thus producing high unit pressures. This load must be transferred to the subgrade in such a way that the smaller unit bearing capacity of the soil will not be exceeded. This transfer is made by the pavement foundation which undergoes some deformation during the process. This deformation results in varying unit pressure on the subgrade, the greatest being directly under the load and the lesser intensities being at points remote therefrom. The extent of this deformation is affected by the thickness of the foundation. This thickness of foundation affects the unit cost of the pavement, which, as before seen, reacts successively upon the several factors and so influences the final cost of transportation.

Second, we have the vehicle in motion, producing an advancing deformation of the foundation simulating a wave action, such that portions before and behind the wheels are slightly raised and negative reactions result.

With the frequent recurrence of passing loads, the subgrade recedes a small distance permanently, thus leaving the foundation to span some depression. Then to some extent the foundation functions as a beam. Its ability to do so depends on its moment of resistance which varies with the square of the thickness. This thickness, as previously noted, affects the cost of transportation. Again the vehicle in motion on a rough road surface imparts impact to the pavement which must be absorbed by the foundation. The ability of the foundation to absorb this energy depends upon its resiliency which in turn depends upon its elastic properties and upon the volume of the pavement deformed. However, this volume depends upon the thickness of the foundation. As before stated, this thickness affects the cost of transportation.

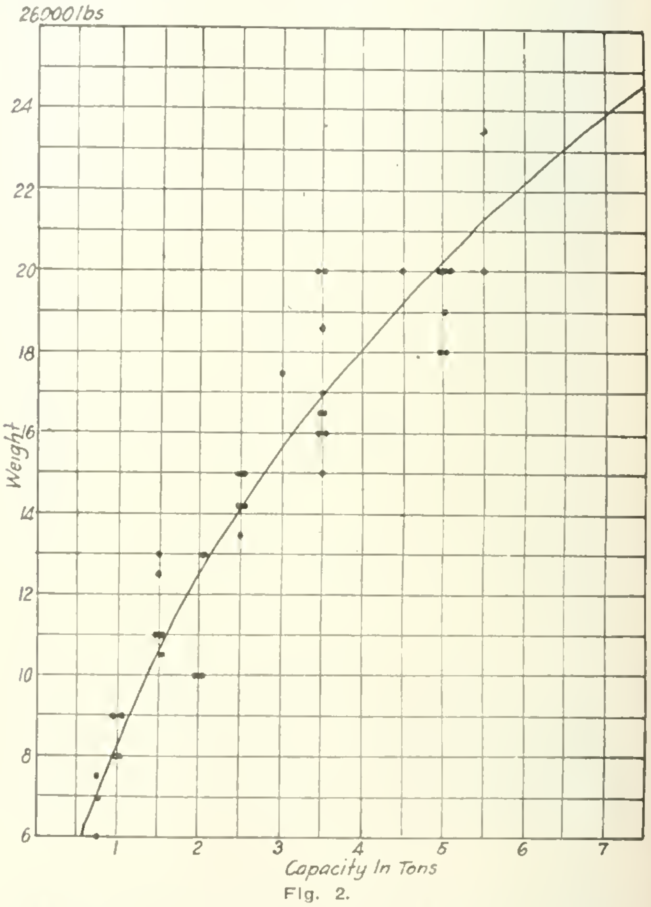


Fig. 2.

Equation. It is essential, therefore, that we establish an equation expressing the relation between the thickness of foundation and wheel load, also between thickness and impact.

Two general phases to be considered, viz:

1. The conditions which the structure must meet, and
2. The methods and assumptions to be made in the design of foundations for meeting the imposed conditions.

In order to get consistent and economical results, these said conditions must be standardized.

The standard load to be transferred to the subgrade is the economic wheel load. This is the load on the rear wheel of

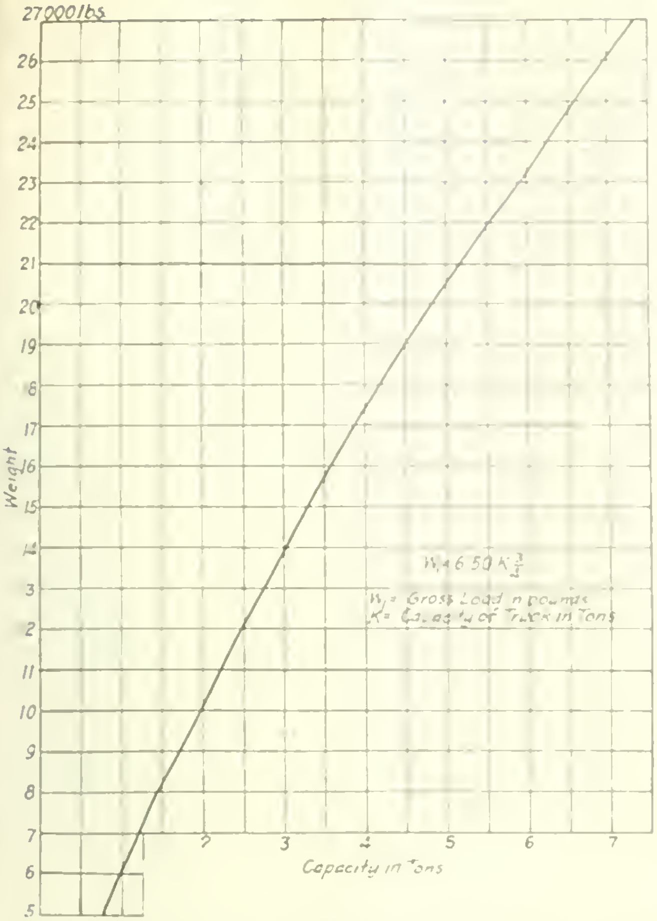


Fig. 3.

the economic truck when loaded with its capacity load. The economic truck is one of a group of similar units forming the economic equipment. The economic equipment is that needed for transporting a given annual tonnage over a particular highway in conformity with the economic balance of the contributing factors. The economic balance is that adjustment of contributing factors [illegible] the minimum cost of transportation.

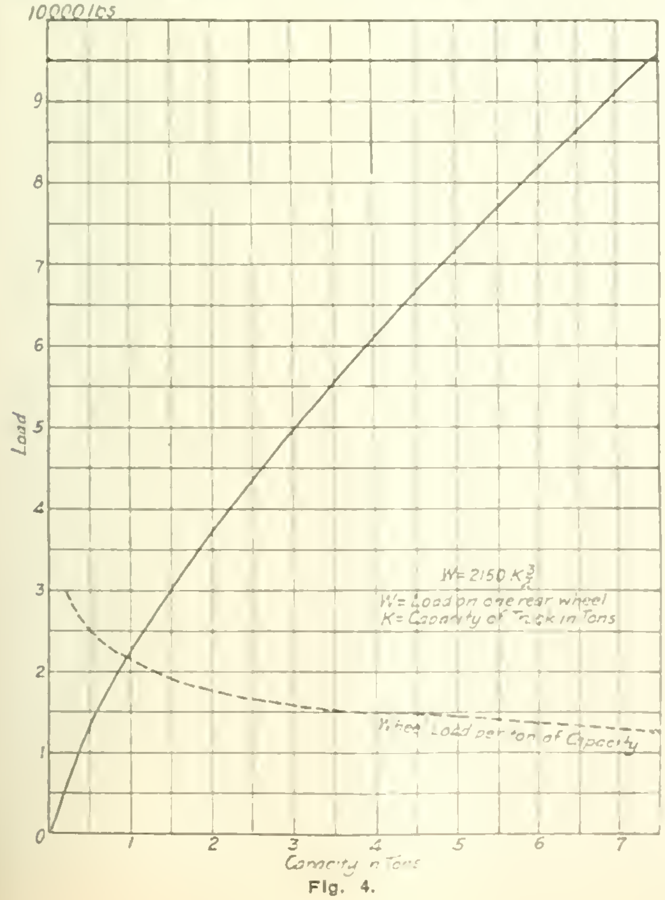


Fig. 4.

The standard amount of impact [illegible] to be provided for in the design of pavement foundations [illegible] that the cost of an increment to the volume of foundation is equal to the cost of an increment of maintaining the road surface. That is, the lack of maintenance [illegible] a rough road surface which increases the impact and which must be allowed for in the design or the actual unit stresses [illegible] the allowable. In other words, it becomes a question of spending money on maintenance or on thicker foundations. The minimum cost is attained when the impact is such that the above mentioned increments balance each other.

It is thus seen that before [illegible] can be made in design, we must be able to assign [illegible] values to the economic wheel load and to the economic amount of impact.

The economic wheel load is directly related to the economic truck, which is measured in terms of its capacity load. From the preceding chart showing items of cost with their contributing factors, it is seen that the factor of load capacity affects 17 cost items. This means that we must be able to write the seventeen equations expressing cost in terms of the contributing factors, including load capacity. The factor of load capacity would then be treated as a variable while the other factors would be considered as constants. The part of the total cost affected by load capacity would be the sum of seventeen cost items, and such a value of the load capacity factor would have to be selected as would make this sum a minimum.

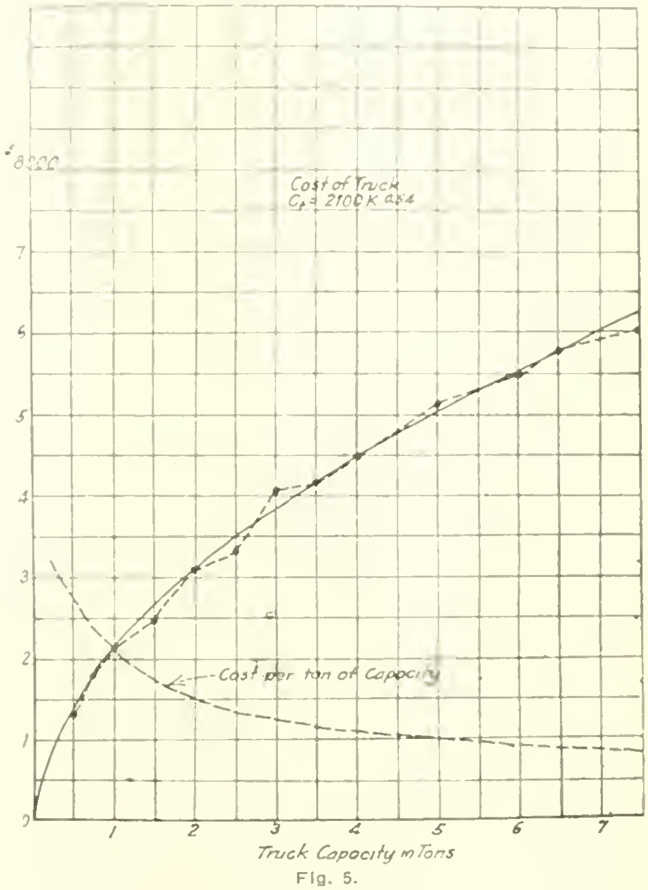


Fig. 5.

Eleven of these seventeen equations can now be formulated with some degree of assurance, but the remaining six involve factors of maintenance for which there is not yet sufficient data available to trace a relationship.

As the relation between capacity load and wheel load, weight of truck, and cost of truck enters into many of these equations, charts have been prepared to show such functions. (See Figs. 1, 2, 3, 4, and 5.) It should be noted that the unit cost and unit weight decrease as the capacity of the truck increases, indicating that greater economy is to be found in the use of larger trucks if other contributing factor do not conflict.

Passing from the consideration of the physical and economic conditions which the structure must meet, we will next review the methods and assumptions of design.

The Broken Stone and the Slab Types of Foundations.—

The broken stone type resists deformation through the resistance of the particles to sliding upon each other. It is thus able to diffuse the load, or pressure, over an increasing area as the depth increases. It has small ability to function as a beam unless mixed with a binder capable of developing tensile strength, nor can it absorb impact unless the binder has elastic properties. It is essential that the load be distributed over a sufficient area by the time it is transmitted to the subgrade, so that the allowable unit pressure will not be exceeded. The greatest intensity of pressure is directly under the load diminishing for points farther therefrom. Investigation* shows that this intensity varies as the ordinates of the "probability curve" as defined by the equation

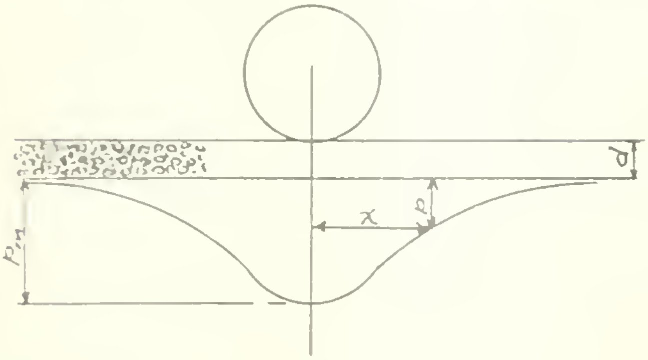


Fig. 6.

$$p = \frac{p'h}{e^{hx}}$$

where

p = intensity of pressure at distance x from the load.
p' = intensity of applied load
h = a factor depending upon the depth of subgrade below top of foundation
e = base of natural system of logarithms = 2.7183

Experiments on stone ballast indicate that the intensity of pressure directly under the load varies inversely as the five-fourths power of the depth below the top of ballast. Figs. 6 and 7 show the form of these two functions.

It will be seen that for practical purposes a parabola passing through the apex and the two points of inflection of the curve in Fig. 6 will serve our purpose as well as the original curve. As p would hold for the distance x taken along any line radiating from the wheel load, we would have in effect a paraboloid of revolution representing the upward pressure or reactions, the sum of which must equal the wheel load. The maximum intensity of pressure is readily found from Fig. 7.

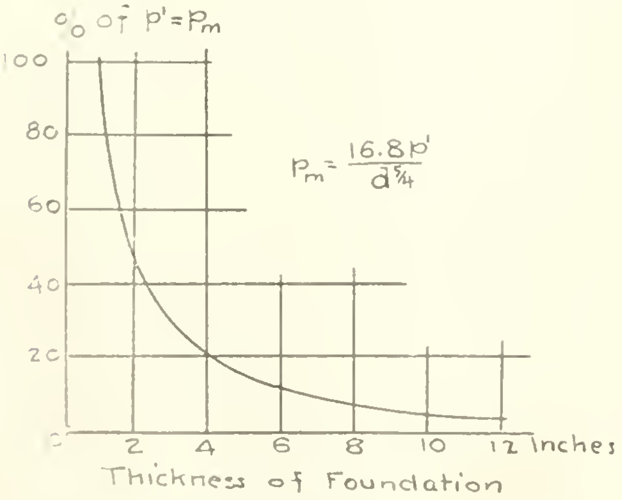


Fig. 7.

The slab type of foundation is one that can function as a beam. It is able to distribute the load over a larger area for a given thickness of foundation, than the broken stone type, and can also absorb impact. It undergoes under load a somewhat different deformation than the other type. Investigations† indicate that the elastic curve takes a form shown in Fig. 8.

This curve of pressure intensities is defined by the equation

$$p = \frac{kW}{2e^{kx}(\cos kx + \sin kx)}$$

in which

p = the intensity at any point distance x from load
W = wheel load
e = 2.7183

and $k = \sqrt[4]{\frac{u}{4EI}}$ u is an elastic constant denoting the pressure per unit length necessary to depress the foundation one unit.

This intensity of pressure, p, would hold for any distance x taken along radial lines and we would have a solid of revolution representing the reactions. In this case we have both positive and negative reactions to consider. As the algebraic sum of these reactions equal the wheel load, the negative reactions furnished by the weight of the pavement decrease the maximum intensity of the pressure under the wheel load. This maximum intensity is given by the equation

$$p_m = \frac{kW}{2} = \frac{W}{2}\sqrt[4]{\frac{u}{4EI}}$$

As the moment of inertia, I, varies as the cube of the depth, the intensity of pressure directly under the load varies inversely as the three-fourths power of the thickness of the slab.

As the maximum allowable intensity of pressure may not exceed the bearing capacity of the soil, p_1 may be equated to that unit bearing capacity. Letting B represent this unit bearing capacity, we can now write two equations connecting thickness of pavement with the wheel load, thus

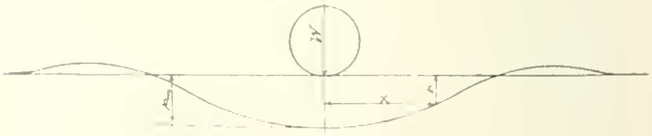


Fig. 8.

For the broken stone foundation

$$d = \frac{(aW)^{4/5}}{B}$$, a representing the combined constants.

For the slab type

$$d = \frac{(bw)^{4/3}}{B}$$, b representing the combined constants.

Relation Between Thickness of Foundation and Impact.—It is next necessary to establish a relation between thickness and impact.

First, consider the vehicle at rest. The load deflects the springs a certain distance s. This deflection is proportional to the load W, or nearly so. Next consider the vehicle in motion along a smooth pavement while the original deflection of the springs remains constant. When a depression or a hole is encountered, the support for the wheel is suddenly removed for a brief interval and the spring is left free to produce motion in a vertical plane. The force of the constrained spring reacts against the car body and pushes the axle and wheels away from the body. This action is independent of any horizontal motion the car may have. We wish to know how much energy is available for vertical impact. This energy is a function of the mass of the unsprung parts and the vertical velocity at the instant of impact. This velocity is obtained from the differential equation for acceleration. The acceleration is proportional to the force acting on the mass of the unsprung parts. This force is in turn proportional to the distance which the loaded car body has deflected the spring originally, hence the acceleration is proportional to this same distance s. However, as the spring regains its unconstrained position, it exerts less and less force on the unsprung parts and the acceleration decreases. Letting x equal the amount of deflection at any instant, measured from the neutral position of the spring, we have

$$\text{acceleration} = \frac{d^2x}{dt^2} = -fx$$

---

*Report of Special Committee on Track Stresses, Am. Soc. C. E.

†Report of Special Committee on Track Stresses, Am. Soc. C. E.

in which f is the force acting at a [illegible] on a unit of mass. Integrating this expression, [illegible]

$$\text{velocity} = \frac{dx}{dt} = \sqrt{f \ldots}$$

Substituting this value in the formula [illegible] we have

$$E = \frac{mf(s^2 - x^2)}{2}$$

s − x equals the depth of the hole [illegible] by the wheel. This depth of hole may be used as [illegible] measure of the degree of maintenance.

The ability of the foundation to [illegible] this amount of energy depends upon its resilience. For a beam of rectangular section this becomes

$$R = \frac{S^2AL}{18E}$$

in which S = unit stress

A = area of cross section

L = span

E = modulus of elasticity

This would represent the condition which obtains after the pavement has been in use for some time when the subgrade has receded from a portion of the slab. By equating the resilience to the energy of impact we get an expression connecting the thickness of foundation to the drop of the wheel when the vehicle passes over a hole or depression. Thus

$$\frac{S^2AL}{18E} = \frac{mf(s^2 - x^2)}{2}$$

but the area of a cross section of the foundation is equal to the thickness, d, multiplied by the effective width, b. Substituting and solving for d, we have

$$d = \frac{9Emf(s^2 - x^2)}{S^2bL}$$

In this expression m and f are related to wheel load. That is for standardized previously referred to, the mass of the unsprung parts would be a certain percentage of the gross load, as would also the weight resting on the rear springs. The wheel load is related to the gross load, being approximately 70 per cent thereof. The preceding formula can be reduced to the following:

$$d = \frac{CW^2(2s - h)h}{S^2bL}$$

in which

C = a constant

W = economic wheel load

s = original deflection of spring

h = depth of hole in pavement which controls the amount of impact.

The effect of impact is further modified by the resiliency of the tires, the result being to retard the delivery of energy to the foundation. Experiments are needed to determine the extent of this action.

Numerical results cannot be had until investigation has proceeded far enough to extend our analysis.

Progress of Federated American Engineering Societies

Fourteen Engineering Societies having an aggregate membership of 37,233 already are members of the Federated American Engineering Societies, according to a bulletin issued Oct. 15 by the Joint Conference Committee. These societies are:

Alabama Technical Association, Birmingham, Ala.; American Institute of Chemical Engineers, Brooklyn, N. Y.; American Institute of Electrical Engineers, New York, N. Y.; American Institute of Mining & Metallurgical Engineers, New York, N. Y.; American Society of Agricultural Engineers, Ames, Ia.; American Society of Mechanical Engineers, New York, N. Y.; Detroit Engineering Society, Detroit, Mich.; Engineering Association of Nashville, Nashville, Tenn.; Engineering Society of Buffalo, Buffalo, N. Y.; Florida Engineering Society, Gainesville, Fla.; Kansas Engineering Society, Topeka, Kan.; Technical Club of Dallas, Dallas, Tex.; The Cleveland Engineering Society, Cleveland, O.; The Society of Industrial Engineers, Baltimore, Md.

Special Pitch Filler for Wood Block Pavements

In its report submitted at the recent convention of the American Society for Municipal Improvements, the Committee on Specifications for Wood Block Pavements, of which Ellis R. Dutton, is chairman, submitted a specification for a special pitch filler which had given good service in Minneapolis paving work. The filler was first used the season of 1919. There was no difficulty with bleeding and no complaints were entered, as in previous years because of the tracking of the sticky tar into the houses and stores and the soiling of floors, rugs, etc. No trouble developed the next season and the pavements are almost entirely free from any tar on the surface. There was one street paved in 1919 which has shown bleeding and on which this special pitch filler was not used. The following analyses shows the difference between the fillers which are non-bleeding and bleeding.

	Non-bleeding Hennepin Ave.	Non-bleeding Cedar Ave.	Bleeding 1st Ave. S.
[illegible]	[illegible]	1.796	1.2[illegible]
[illegible]	0	[illegible]	0
[illegible]	[illegible]	1	0
[illegible]		[illegible]8	[illegible]
[illegible]	[illegible]	[illegible]8	0
[illegible]	[illegible]	18.0	[illegible]
[illegible]	4	22.6	12.5
[illegible]		0	0

The theory upon which the "non-bleeding" special pitch filler was based was the use of a high melting point pitch cut back with a volatile solvent or oil. When used the material would flow readily into the joints and not remain on the tops of the blocks and after the volatile part had evaporated, the joints would be only partly filled with a high melting point pitch. By having the joints only partly filled, the expansion of the blocks would not force the pitch to the surface of the paving, as happens with the ordinary pitch filler, thereby causing the bleeding. This special pitch filler was developed for use with creosoted wood block paving laid on a smooth top concrete with a bituminous cushion and could not have been used successfuly with a sand cushion.

The specification as submitted by the committee follows:

Special Pitch Filler.

Note.—To be used only where bituminous cushion is used.

The filler shall be made from the products obtained from the distillation of coal-tar only, no admixtures of other materials will be permitted, and it shall comply with the following requirements, the tests made as indicated.

1. The filler shall contain no water.

2. Its specific gravity at 15.5° C. (60° F.) shall be not less than 1.2[illegible] nor more than 1.23.

TESTS.

Apparatus—Modified Hubbard Bottle.

(a) Standardization of Bottle. The bottle shall be weighed empty, filled with distilled water and held in a bath at 15.5 C. (60 F.) until the volume becomes constant. The water shall then be adjusted to the mark, the bottle dried superficially and weighed.

(b) Method. Introduce about 10 gms. of the material into the bottle at about 40-50° C.; allow to cool and weigh. Freshly boiled distilled water shall then be added and the bottle kept in a bath at 15.5° C. (60° F.) until no further volume-change takes place. (This usually takes about 30 minutes.) The water shall then be adjusted to the mark, the bottle dried superficially and weighed.

(c) Calculation. Let A = Weight of bottle, B = Wt. bottle + water at 15.5° C., C = Wt. bottle + material, D = Wt. bottle + material + water at 15.5° C. Then: Sp. gr. at 15.5° C. $= \frac{C-A}{(B-A)-(D-C)}$

3. Distillation. When distilled as below required it shall show percentage distilled by volume as follows:

From 0 to 1% at 100° C. (212° F.).

From 1 to 10% at 170° C. (338° F.).

From 20 to 40% at 355° C. (671° F.).

TESTS.

(1) Apparatus. Adapted from "Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment." A.S.T.M. D 20-16.

Flask. The distillation flask shall be a 250-cc. Engler distilling flask of standard dimensions.

Thermometer. Shall preferably be an "A.S.T.M." distillation thermometer and graduated from 0° to 400° C. at intervals of 1° C.

Condenser. The condenser shall have the following dimensions:

Adapter	70 mm.
Length of straight tube	185 mm
Width of tube	12-15 mm.
Width of adapter and of tube	20-25 mm.

Cylinders. Suitable size and graduation.

(b) Method. The apparatus shall be [illegible] that the bulb of the thermometer is opposite the middle of the [illegible] arc. All connections shall be tight.

100 cc. of the material shall be placed in the tared flask and weighed. (It is usually impractical to accurately measure 100 cc. of the material. Therefore the weight [illegible] corresponding to 100 cc. should be calculated from the predetermined specific gravity and this amount weighed into the flask. For example, if the specific gravity is 1.18, the operator should weigh out 118 gm. for the test.) After adjusting the thermometer the distillation is commenced, the rate being so regulated that [illegible] passes over every minute. The receiver is changed as the mercury column just passes the fractionating point.

4. The specific gravity of the distillate at 15.5° C. (60° F.) shall be from 0.950 to 1.05.

5. The melting point of the residue by the air-bath ½-inch-tube method shall be from 117.8° C. (244° F.) to 126.7° C. (260° F.).

The Need for the Federated American Engineering Societies*

Some of the reasons for forming the organization of engineering societies known as the Federated American Engineering Societies are given in the following excerpt from the address of Arthur P. Davis, president of the A. S. C. E., at the annual convention of the society in Portland, Ore.

The demand for active participation of all engineers in civic and other work for the general benefit of mankind and the advancement of the engineering profession has been growing for many years and is greater today than ever before. Various plans for accomplishing this purpose are suggested and the pressure has been such that the American Society of Civil Engineers and other founder societies have each taken a more or less active part in such work.

Recognizing the necessity of combining efforts in this line and also the desirability of somewhat separating such activities from the technical functions of these societies Engineering Council was formed with the idea that it would represent the four founder societies and gradually add to this number through powers conferred upon it for that purpose. It has in the three years of its existence added the American Society for Testing Materials and the American Railway Engineering Association, but is still far from embracing all of the engineering societies of the country. It has some fundamental weaknesses. It lacks in representative character and democracy and is without power to raise funds, but must depend upon voluntary contributions from its constituent societies and others. Experience has shown that these deficiencies can be best remedied by substituting a league or federation designed to include all of the engineering societies, national, state, regional and local.

A constitution to this effect was adopted at the convention in Washington in June. The federation does not provide for any individual members but is merely an instrument for combining the efforts of existing societies by forming them into a federation with definite powers and provided with sufficient funds to accomplish its purpose.

Measures of great importance to the world, to our country and to our profession demand immediate and vigorous attention and it is imperative that they have behind them the unified efforts of all the organized engineers of the country and all the prestige that the greatest, the oldest and the most eminent societies can offer.

Among these measures are the unification of the engineering work of the government under one department with a technical head. This will promote efficiency and eliminate waste; and, what is more important, will serve as a precedent for the reorganization of other departments along similar lines of homogeneity, efficiency and economy.

The spirit of progressive movement is summarized in the terms "service through co-operation." It means service to mankind, to our country, to our profession and to ourselves. It cannot reach its fullest expression without the active cooperation and influence of every engineering organization in the country.

We cannot act effectively unless united and by calmly reasoning together on pressing questions, guided by the pole star of righteousness, we can unite upon fundamental principles and make our influence for good a power in the land and only thus can we perform the duty we owe to ourselves, to our fellowmen and to posterity.

---

*From the American Machinist, Oct. 21.

Specifications for Gravel for Road Construction*

By WALLACE F. PURRINGTON.

In drawing up any specification to cover gravel used in road construction, there are certain facts which must be kept in mind. The foremost question of all is, are the specifications workable? A theoretical specification based on laboratory findings alone may be very impracticable in the field, owing to the fact that the deposit from which the samples were collected is not homogeneous, so that the samples tested do not fully or accurately represent any large part of the deposit. In the second place, specifications may work well or badly, according to whether or not the purchaser has the equipment or technical knowledge to check up the different items of composition in the specification.

At the present time most specifications covering gravel are (to the writer's mind) very ambiguous and wholly impracticable to put into operation. Many states make a practice of using screened gravel, but for the expense involved and the results obtained, New Hampshire, and it has many miles of very good gravel road, has found this procedure unnecessary. If the manipulation of run-of-bank gravel is properly supervised, the results obtained are equal to those with the screened material. In the first place, gravel usually is defined as the material passing a 3½-in. screen; then a ¼-in. screen is interposed and two distinct sizes of material are separated. The material retained on the ¼-in. is arbitrarily called gravel or coarse aggregate and the material passing it is called sand or fine aggregate. Specifications commonly attempt to set limits to the ratio of gravel to sand which shall be such as to guard against the gravel being too sandy on the one hand or too cobbly on the other.

This might be very satisfactory if gravel deposits were generally uniform and homogeneous in texture; but that is not the case, the gravel deposits which are most abundant and accessible all through the northern states, deposits left by flooded rivers during the closing stages of the Ice Age, are notable heterogeneous in structure and texture. The long narrow ridges or "eskers" of the New England States, and the shorter, interrupted ridges and hummocks of gravel, called "kames," show abrupt variation in the deposit, from the fine sand to coarse, cobbly gravel, both in vertical section and lengthwise; so that a sample taken at one level or at one point may give a very incorrect idea of the average run of gravel from the face of the bank, and is no guide whatever to the quality of material that will be found 50 or 100 ft. farther in.

These banks were built by rivers running through and out from the melting ice sheet, where great floods during warm days or weeks alternated with sudden droughts when severe cold waves checked the wastage of the glacier. This spasmodic behavior of the glacier rivers accounts in large measure for the variability of the material in most "bank" gravels. Even the wash plains and valley-terrace gravels which accumulated beyond the reach of the ice sheet show too much variation in texture, both vertically and horizontally, to yield samples that would afford an adequate basis for judgment in the laboratory of what can so readily be seen in the field. A demonstration of this fact, by a study of scores of samples from a single deposit, has been given by Reinecke and Clarke in a paper entitled, "The Sampling of Deposits of Road Stone and Gravel in the Field," and published in the Proceedings of the American Society for Testing Materials, Vol. 18, part 2, 1918. Their conclusions were summed up as follows:

"A large variation was found between results of duplicate granulometric laboratory analyses on the same sack of gravel. The variation in texture over one deposit of gravel of 800 acres was found to be large."

An inspection of almost any bank in New Hampshire will illustrate the truth of the foregoing statement, and the futility of depending upon a single sample or many samples to pass judgment on a given deposit. The desired result is far more likely to be gained by making the texture (coarse or fine) and grading (uniform, streaky, etc.), matters for field inspection by the engineer in charge, and leaving the laboratory to test only the resistance-to-wear of the gravel. Assuming then that the material is composed of hard durable stones, the rather overworked phrase "such as will meet the approval of the engineer," can well be used. This means more for the proper construction of gravel roads than any theoretical grading system that may be adopted.

---

*Paper presented Oct. 14 at the annual convention of the American Society for Municipal Improvements.

In New England and the Northern States, three sorts of material usually compose the gravel pavement of a road, gravel sand, and till (which last is commonly called "hard pan"). According to the proportion in which two or more of these are combined, such roads should be designated as, "sand-gravel," "till-gravel," or "sand-till gravel" road. The choice as to which type of gravel road is to be built will depend largely upon the material found in the subgrade. The finer material is added to fill the voids in the coarse aggregate, and acts as a binder. The state, being the purchaser, may well tell the contractor whether clay, till, or sand shall be used. It might also say that the base-course shall be of gravel, the larger stones predominating, and that the wearing or top-course shall be such that much smaller stones shall predominate. This sort of statement is comprehended by all parties interested. The engineer, inspector, contractor or government representative has an intelligent basis from which to draw conclusions and a far more honest statement than could be obtained by a chance sample showing that 59 or 63 per cent is retained on a ¼-in. screen. Such a specification is not only misleading, it is positively absurd.

The soundness or durability of the stone comprising the aggregate is however a matter of considerable importance. Fortunately, we have a rational method of gaging this in the Rea modification of the DeVal abrasion test as described in the Bureau of Public Roads Bulletin No. 555, page 30. By this test it is possible to place certain arbitrary values which ordinarily should not be exceeded.

A few outstanding facts will serve to summarize what has been said concerning gravel specifications: (1) The greatly increased demand by the public for good roads cannot be met in every community by adopting the heavier and more costly types of construction. Gravel and earth roads must still be very generally built, and local materials thus used. As the item of screening of gravel is quite costly we may well consider its elimination, as the question of its efficacy is open to question. (2) Specifications for the material to be put into such gravel roads must be plain and straightforward; so far as grading is covered, the specifications must be based upon what a reliable engineer sees at the pit where the deposit is fully exposed not based upon the laboratory screening test of a sample or a group of samples, from a deposit which in all probability varies greatly in texture. (3) A laboratory test of the per cent of wear of the coarse aggregate, according to the Rea-DeVal test, should be made a part of the specification, to insure that the material consists of sound, durable stones. (4) The character of the fine aggregate or matrix should be left to the judgment of the engineer. (5) A little theory, mixed with a lot of common sense, is better than the reverse.

With these points in mind, after conducting an extensive field and laboratory survey of gravels, the state of New Hampshire has adopted the following specifications:

Gravel is to be understood to be a water-laid, stratified deposit which consists of rolled and rounded stones accompanied by sand and clay in varying proportions. The stones (or coarse aggregate) shall be hard and sound and well assorted, in sizes up to but not exceeding 3½ in. in long diameter. The resistance to wear shall be determined by the modified abrasion test described in bulletin 555, page 30, of the U. S. Department of Agriculture, office of public roads, and the gravel thus tested shall be classified as follows.

Class A, hard gravel under 7 per cent wear.
Class B, medium hard gravel from 7 to 10 per cent wear.
Class C, medium soft gravel from 10 to 15 per cent wear.
Class D, soft gravel above 15 per cent wear.

Classes A and B may be used for either or both base or surface course. Class C will not be used for surface course and gravel of D quality will not be used except by written permission of the Commissioner.

The texture (coarseness or fineness) of the aggregate from any source of supply of gravel shall be such that it shall meet the written approval of the Commissioner. No gravel shall be used until a complete report has been made by the engineer regarding its qualities, and the approval of the Commissioner has been obtained specifying the class of work for which its use is approved. The approval shall be furnished on a form which shall contain the following information:

1. Account to which work is to be charged . . . .
(Town)
2. Nature of material, gravel, sandy gravel, sand, till, clay
3. Source of material . . . .
(Local name) (Location)
4. Type of material [illegible]
5. Contractor or F[illegible]
6. Grading of pit ([illegible]) which best fits the [illegible]
(a) Uniform and [illegible]
(b) Uniform and w[illegible]
(c) Streaky or [illegible] predominating.
(d) Streaky or p[illegible] predominating.
(e) Sandy with only [illegible]
(f) Cobbly with only [illegible]
7. The Laboratory has reported [illegible] from this source under Laboratory No. [illegible] % of wear and is rated as [illegible] gravel.

. . .

[illegible]ineer

This is satisfactory material and [illegible] the base [illegible] surface course.

[illegible]

By .

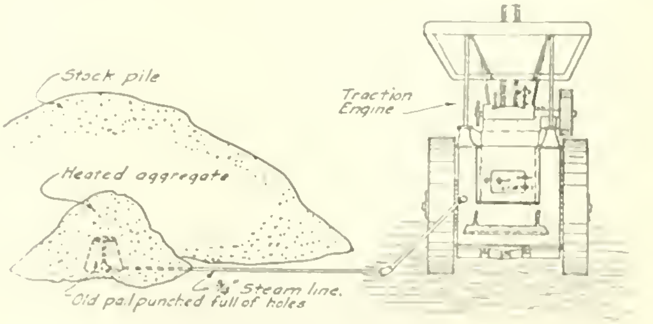
These blanks shall be executed in quadruplicate, one copy to be furnished the contractor, one copy to the Office of Public Roads, one copy to the Commissioner and one copy to be retained by the Engineer.

It is understood that the Engineer may order the contractor to cease operation in any pit when in his judgment the size of aggregate is not suitable for the type of road construction under consideration.

Novel Method of Heating Aggregates for Cold Weather Paving Job

Concrete driveway construction during temperatures ranging from 9° below zero to 36° above was successfully carried out last December by the Moore-Young Construction Co., Waterloo, Ia. The work involved the laying of 1,700 sq. yd. of 7-in. concrete industrial driveway between Dec. 13 and Dec. 26, 1919. The methods employed are described in the October-November Concrete Highway Magazine.

The weather conditions were severe during the time concrete was laid, calling not only for heated aggregates and water but adequate protection for the men and the work. A tent 100 ft. long and 40 ft. wide was set up and the interior heated by means of 12 salamanders. As the work progressed and the concrete had hardened sufficiently to permit, a section of the tent was taken down, carried ahead and set in line with the pavement. Due to irregular placing of the buildings on each side of the road and a line of poles running its full length, no movable frame could be devised for the tent shelter. Therefore, the moving of tent sections was slow and somewhat expensive.



Method of Heating Aggregates.

The mixer was housed in at a central location and the heated aggregates were moved to the mixer in wheelbarrows. Concrete was from 55 to 60° F. when placed. It was moved to the work in open dump wagons, an average distance of 500 ft. During this movement it lost from 5 to 10° F.

A section 40 ft. wide and about 30 ft. long was laid each day. After 24 hours this section was covered with building paper and a foot of manure. No section remained more than 24 hours under the tent.

The method of heating sand for this job was especially successful and is shown in an accompanying sketch.

Some difficulty was experienced in heating the tent as the gas from the salamanders was objectionable to the men working in the enclosure.

Central Mixing Plant Lays 918 feet of 18-ft. Concrete Road in 10 Hours

With a crew consisting of from 28 to 31 men, McCree, Moos & Co., Contractors, St. Paul, Minn., averaged 1,360 sq. yd. of Minnesota state highway specification concrete pavement per 10-hour day during the first 11 days of October. On Oct. 11 they laid 2,196 sq. yd. of pavement in less than 10 hours. They ran out of cement at 4 p. m.

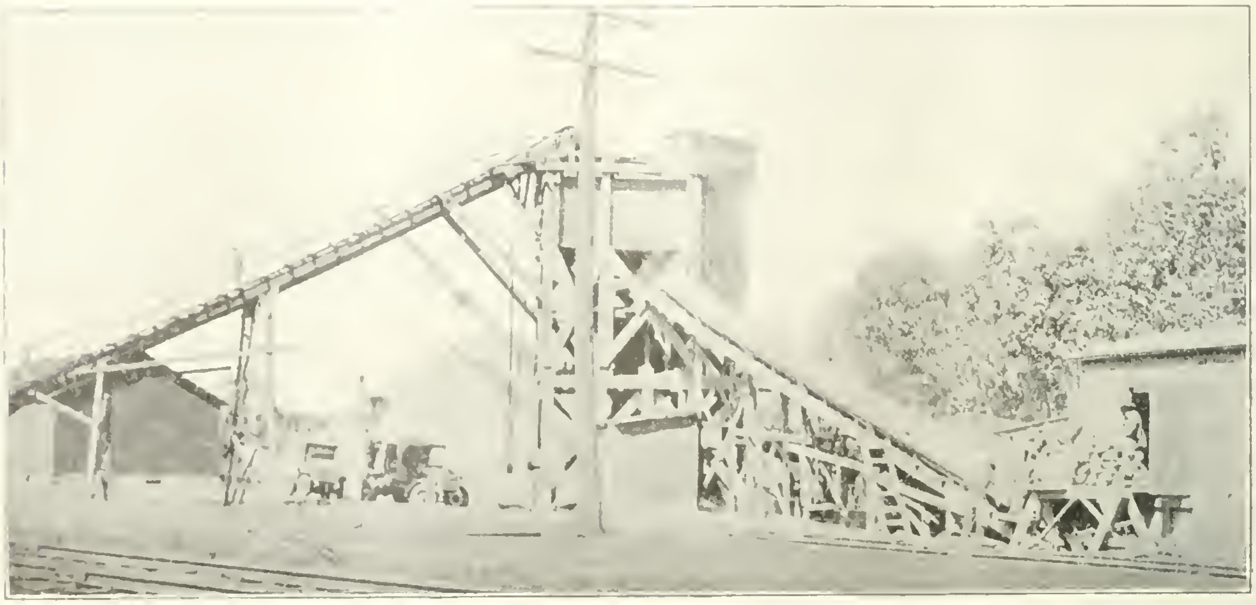
The McCree-Moos contract covers 7½ miles of road running north and south from Big Lake, Minn. It is an 18-ft. highway, one course concrete pavement, 6½ in. thick on the sides and 7½ in. thick in the center, the average thickness being termed 7 in. A 1:2:4 mix was used, as allowed by the state of Minnesota when a machine tamper and finisher is used. The state specifications on "composition" are as follows: "This concrete shall be composed of 1 part portland cement, 2 parts fine aggregate and 3½ parts of coarse aggregate unless the machine tamper and finisher is used, in which case 4 parts of coarse aggregate may be used.

The state's clause specifying "consistency" reads as follows:

"Sufficient water shall be used in mixing to produce a concrete which will meet with the following test: When placed and tamped in a cylinder 6 in. in diameter and 12 in. high and the form removed, the concrete shall have a vertical settlement of not more than 2 in. when machine finishing is employed and not more than 6 in. when hand finishing is employed."

The dry mix was necessary, therefore, on this job. A full minute mix was strictly adhered to.

The contractors used a 1-yd. Smith tilting mixer operated by a central mixing plant. This plant was located in Big Lake at the half-way point of this road so that the maximum haul for the mixed concrete to either extremity of the road was 3¾ miles.



Central Mixing Plant. The Sand and Cement Are Carried to the Hopper by the Belt Conveyors; the Stone Is Placed in the Hoppers by the Clam Shell and 85 Ft. Boom Derrick.

The handling of materials at the central mixing plant was very efficiently and simply arranged. The cement in bags is unloaded direct from the cars into a warehouse at the plant. A belt conveyor leads from the warehouse to a hopper directly over the mixer. The bags are opened in the warehouse and the cement, six bags at a time—enough for one batch—is dumped upon the belt conveyor which carries it up to the cement hopper.

Truck With Special End Dump Body, Ready for Load.

Concrete Is Delivered to Road by Truck, Spread by Horse Drawn Buck Scrapers and Tamped and Finished by Machine.

The sand is brought from a pit, 1¾ miles away, to the central mixing plant, by 2½-ton end-dump trucks. The trucks deposit the sand into a trap, from which another belt conveyor elevates it to a second hopper over the mixer. This sand hopper has a capacity of 20 yd.

The crushed stone is St. Cloud granite and is shipped to the plant in gondolas. A 1-yd. clam shell bucket on an 85-ft. boom derrick unloads from these cars directly into a third hopper over the mixer. The stone hopper has a capacity of 20 to 25 yd. When filled, the surplus crushed stone is unloaded into a stock pile behind the derrick and then the hopper is kept supplied from this stock pile.

The batch hopper of the mixer is subdivided to hold the correct proportions of cement, sand and crushed stone which are fed into the batch hopper from the respective material hoppers directly above it.

After the 1-minute mix the mixer discharges its entire batch in 8 seconds into a bottom dump hopper arranged just high enough to permit the trucks to drive under beneath it. This hopper for the mixed concrete will hold two full batches, 2 cu. yd.

The wet concrete is carried to the road by motor trucks, 2½-ton capacity, special short wheelbase, equipped with end-dump bodies manufactured by the Lee Trailer & Body Co., Chicago. These bodies have a level capacity of 2 yd. but are usually loaded with about 1½ yd. of concrete. After the concrete was delivered on the surface it was spread by horse-drawn scrapers. The contractors state that this method greatly facilitates the work of finishing.

The first stretch of road laid on this contract was started 1½ miles north of the mixing plant working south. When this section had been completed up to the mixing plant, the work was started 1½ miles south of the town of Big Lake, working north. When this 3 mile section was completed and ready for traffic, the work was started at the extreme northern extremity of the road, 3¾ miles from the mixing plant, working south again. This system enables the trucks to travel 1½ miles over the new concrete road with their loads of concrete and continually cuts down the stretch that has to be traveled over the unpaved roads.

Compression Tests of Field Samples of Concrete Pavement

During the past 2½ years about 100 miles of concrete pavement has been laid in Sacramento County, California. The work has been done by means of a county bond issue of $1,750,000 under the direction of the Sacramento County Highway Commission, the present members of which are F. B. McKevitt, W. S. Caruthers and R. C. Irvine, all of Sacramento. The completion of the final 13½ miles of pavement has been delayed because of difficulties regarding the routes, notwithstanding which Sacramento County now has about 225 miles of improved highways within her borders. The planning and construction of the recent system of concrete highways was under the supervision of E. M. Morton as Chief Engineer.

Practically all of the concrete base pavements were constructed to a width of 15 ft., and 4 to 5 in. in thickness. The mixture of concrete used was in the proportion of 1 part of cement, 2½ parts of sand and 5 parts of rock. Excellent materials were generally available for construction. Much of the sand was shipped from the Yuba River and consisted of clean white quartz sand of fair grade. The rock generally used consisted of crushed cobbles, obtained in Sacramento County from the plant of the Natomas Company of California, usually graded to form a special concrete mixture. The rock ranged from ½ in. to 2½ in. in size, with crushed and uncrushed gravel in about equal proportions.

The cement used was obtained from the Henry Cowell Lime & Cement Co. of San Francisco, and is an excellent grade of hydraulic portland cement.

Typical sand gradings are shown below, of six varieties of sand used on the work:

AVERAGE SAND GRADINGS, SACRAMENTO COUNTY, CALIF.

Total percentage passing sieve numbers

	200.	100	80	50	40	30	20	10	4
(1) Yuba River	.21	1.75	3.0	17.3	41.8	61.9	87.5	95.1	100
(2) Consumnes River	.3	0.8	1.8	6.7	11.[illegible]	22.2	70.7	95.1	100
(3) American River	3.2	6.6	7.9	17.3	28.9	41.5	78.3	90.8	100
(4) Natomas washed screenings	1.1	4.2	5.9	20.2	48.8	53.[illegible]	76.[illegible]	90.7	100
(5) Sacramento River	1.7	2.0	4.[illegible]	11.[illegible]	21.8	42.[illegible]	71.1	91.1	100
(6) Enwood	0.15	0.3	0.45	1.60	1.8	11.7	29.8	63.6	100

In the spring of 1919 the idea was conceived that a series of compression tests on samples cut from the pavements already installed, some of which had been in use nearly two years, might furnish interesting information to highway engineers generally, as well as data upon which to base conclusions regarding the strength which might be expected from field concrete of the type used. The pavements were unsurfaced and without exceptions were resisting the traffic in a highly satisfactory manner. Arrangements were perfected with the California Highway Commission to obtain the use of a Calyx core drilling machine mounted on a motor truck, which outfit had been built by the Commission for the purpose of sampling their pavements. This drill cuts a clean core 4½ in. in diameter.

The machine was obtained in April and sent out over the various roads in charge of one of the assistant engineers of the commission. On most of the roads the instructions were to obtain random samples about one in each mile. In several cases where unusual conditions during construction had been encountered additional samples were to be obtained at locations designated.

During April and a portion of May a total of 118 samples were taken, the average being about 8 per day, including the lost time of moving from one road to another. The time for cutting each sample varied from 10 to 40 minutes. Concrete made with Yuba River sand and Natomas rock averaged from 20 to 30 minutes per sample. The amount of No. 9 chilled steel shot used per sample averaged 2.4 lb.

It is to be regretted that the samples obtained did not have sufficient height, owing to the pavement thickness, to make the ratio of the height to the diameter the standard two to one ratio, and without doubt the breaking strengths found are higher than would have been found if the samples had conformed to the two to one ratio. The results in the table below are believed to be from 16 to 19 per cent greater than would have been the case if the breaks were made on standard sized samples.

The following table shows the name of the road from which the samples were taken, the number of samples, the range of their age in days, their average height, the average density of samples on each particular road, and the average compression required to break the samples. The average compression of all the samples was 3,070 lb. Thirteen samples broke above 4,000 lb., the highest being 4,609 lb.

Road.	No. samples.	Age in days.	Average height, in.	Average density.	Average break.	High break.	Low break.	Sand used.
*Marysville	9	243-585	4 1/3	2.355	2,755	4,236	2,110	1
*H Street	19	426-707	4 9/38	2.489	3,697	4,511	2,700	3
*Fair Oaks-Greenback	4	545-638	5 1/16	2.360	2,943	3,418	2,370	1
*Greenback Lane	8	580-770	4 6/64	2.305	3,211	3,823	2,765	1&4
Jackson	27	29-369	4 71/216	2.411	3,360	4,384	2,290	2
*Florin-West	2	585-599	3 15/16	2.35	2,632	2,680	2,610	1
*Florin-Perkins	4	513-640	4 1/16	2.55+	3,077	3,974	2,580	1
*Elk Grove-Franklin	4	665-732	4 1/16	2.42+	3,233	3,700	2,990	1
*Elk Grove-Sheldon	5	550-655	4 7/20	2.477	2,776	3,145	1,635	1
*Lower Stockton	8	149-665	4 19/64	2.370	3,057	3,222	2,800	1
*Galt-New Hope	7	68-659	4 1/8	2.384	2,841	3,635	2,230	1
Clay Station	7	20-78	3 47/56	2.513	2,895	3,522	2,579	1
*Freeport	6	539-701	4 1/4	2.432	3,613	4,609	3,201	1&6
*Rendle Island	4	593-615	4 7/32	2.472	2,602	2,925	2,295	6
District 741	7	64-129	5 11/56	2.395	2,747	3,757	2,201	5
Grand Island	21	57-373	5 2/21	2.32	2,244	2,955	1,700	5
*Pocket	6	307-418	4 1/4	2.43	2,973	3,781	2,640	1

*Machine tamper used.

Considerable variation in compression strength was noted as the result of these tests, on samples taken from pavements similar in materials, workmanship, amount of water, etc. This variation is not accounted for but would seem to indicate that closer regulation of equipment, labor and materials is necessary to produce a concrete of uniform strength. Most of the pavements from which these samples were taken were automatically tamped by means of an early type of road tamper and finisher, but the results do not show that the concrete finished with the tamper possesses any greater strength than that which was tamped by hand. Judging from the structure of the broken samples, the machine tamped concrete seems to contain more rock particles than the hand tamped.

Asphalt Block Hillside Construction.—A recent development in asphalt block street work is the use of the blocks in hillside paving. This type of construction, according to a paper presented at the St. Louis convention of the American Society for Municipal Improvements, by Mr. P. S. Thompson of The Hastings Pavement Co., was first laid in Dobbs Ferry, N. Y., in 1916 on a 9 per cent grade. The concrete foundation and mortar bed are laid in the usual manner. The asphalt blocks are laid upon the mortar bed one row at a time, with a ½-in. wooden strip beneath each course. The wooden strips are then removed and the joints filled with grout, mixed 1 to 1½. Before the grout has taken its initial set it is scraped out of the joint by means of a special tool to a depth of about ½ in. The result obtained by this method is stated to be a smooth pavement with recessed joints, affording protection against slipping of horses and skidding of motor vehicles.

Surface Treatment of Gravel Roads*

By PHILIP P. SHARPLES

[illegible] Tarvia Department [illegible]

During the last few years attempts have been made to utilize the bituminous materials used so successfully in macadam road maintenance in surface treating gravel roads. Naturally much of the success of these treatments has depended on the gravel roads chosen for the experiment. As in the early days of macadam treatment, the attempt has been made to save gravel roads which had so far disintegrated that a surface treatment could be of little use, or to treat roads which were gravel only in name and not in fact. Needless to say, a surface treatment cannot supply drainage, a foundation, or modify a poor construction. Its only office is to protect, by a surface skin, the structure that lies beneath. If the skin cannot be supported, the road cannot be maintained by surface treatments.

Except in certain localities like New England and part of Texas, and scattered points in other states where a fund of practical experience has been accumulated, the bituminous treatment of gravel roads may be said to be in the experimental stage.

The importance of surface treatments is everywhere realized. A gravel road, well built of good materials and sufficiently wide to handle the traffic, can take care of 200 vehicles per day without undue stress, if it is well maintained by the patrol system with an intelligent use of the road scraper and road drag. With an increase in the intensity of traffic, the dust nuisance becomes intolerable, and the road develops pot holes faster than the patrol men can fill them up.

Surface treatment, if it can be successfully worked, seems to hold out the only hope of holding the gravel road under increased traffic. When the cost of replacing the gravel road with some more resistant type is considered, it will be found that a very considerable annual sum can be expended on a gravel road rather than to spend the money to reconstruct it. According to the type considered, the interest on the new construction, the depreciation, and the upkeep will total $2,000 to $4,500 annually, which could well be expended on the gravel road rather than to replace it.

As long as a gravel road is giving reasonable satisfaction with good dragging and patrol maintenance, it should not be surface treated, since the maintenance by surface treatment is more expensive until the traffic reaches a point that warrants its use.

Surface treatments should never be attempted unless provision is made beforehand to insure proper patrol or gang maintenance. Their economy and success depend on proper daily care. It is less expensive to let the gravel road go to pieces in the first place than to surface-treat it and then let it go to pieces.

The application of bitumens on gravel may be divided into three groups:

The application of dust laying oils.

The formation of a bituminous mat.

The formation of a bituminous crust.

The application of dust-laying oils may be restorted to on any type of gravel road. Subsequently, the road is maintained by the ordinary dragging and patrol methods. It must be remembered, however, that the oil destroys the natural bonding quality of the gravel and that in wet weather the oil forms an objectionable greasy mud.

The second method, the formation of a mat or carpet coat with heavy bitumens, either tar or asphalts, is rarely successful, since the mat is not thoroughly supported by the gravel surface and quickly breaks under traffic and scales off.

The third method, of forming a bituminous crust which does not form a separate layer but is anchored firmly into the gravel, has given the greatest success. In this work the refined tars used cold have been especially valuable. They penetrate into the gravels easily and harden just sufficiently under traffic to make the process successful. A material that does not harden eventually produces a wavy surface. Such a surface treatment can be successful only on a road capable of sustaining the crust under the traffic conditions imposed. Needless to say, it must be built of good gravel well drained, of proper strength and of a width adequate for the traffic. Treatments on one track roads are not advisable. If they are adequate for the traffic, they do not need surface treatment. If they are not adequate, they should be widened.

The gravel roads are prepared for the treatment by shaping and dragging during the spring. If new gravel is added, it should not exceed a depth of 2 in. and should be added as early in the spring as possible. Heavy additious of gravel should be made in the fall, and new gravel roads should not be treated until they have weathered a winter and been carefully reshaped in the spring.

The road should be treated in the spring as soon as it is firm and solid. In New Hampshire and Maine, the roads are usually ready about the middle of May, but there is considerable seasonable variation.

Sweeping is usually but not always necessary. Only the dust should be removed and care should be taken not to loosen the gravel.

The refined tar is put on cold, or only warmed slightly to 100 or 120° F. The best results are obtained by mechanical sprayers, putting on two coats. The first is of 0.4 gal., which is allowed to dry in without cover, which usually takes 6 to 24 hours in dry, sunny weather. The second coat of 0.3 gal. follows. If this is not quickly absorbed, it is covered with just enough coarse, sharp sand or fine gravel to prevent the bitumen from picking up on the vehicle wheels.

After the work has been completed, the road should be given careful patrol maintenance. Breaks will develop over soft spots in the gravel, and these must be patched with a mixture of gravel and refined tar. The patrolman should be supplied with 4 to 10 bbl. of refined tar per mile at convenient spots for this work. As soon as the first batch of weak spots has been eliminated, a good gravel road requires comparatively little attention, even under heavy traffic. The trunk highway between Portsmouth and Portland carries 2,000 to 3,000 vehicles per day on this construction.

The treatment usually carries a road through the winter, but whether it breaks up during the spring depends on the road construction, the traffic and the weather conditions. After a hard, snowy winter, the road is not likely to break, but after a soft, open winter, it is quite sure to act like an ordinary gravel road.

If it does not break up, it is given a further treatment of about ¼ gal. per square yard, and this usually requires a cover of sharp sand or small gravel, using about 1 cu. yd. to 300 sq. yd. of area.

If the road breaks up, it is treated like any other gravel road—shaped up and dragged back into shape. The time when this can be done is short, and it is necessary to work quickly. If the road once hardens, ordinary road machines have little effect on the surface. The re-shaped road is then re-treated. Usually ¼ to ⅓ gal. per square yard will be found sufficient to restore the surface and carry it through the season.

Roads that do not in themselves break up may, after a few seasons, become rough through frost displacement or through poor maintenance. A road becoming rough should be broken up in the spring. The road roller with a steam scarifier are efficient tools for this purpose. After breaking, the road is harrowed back into shape and re-rolled. It is then given a treatment of refined tar and treated like the road that has broken naturally. The refined tar in the road sticks the gravel together in chunks to some extent, and the road often is smoother and wears better than ever before.

The cost of the breaking up is not excessive. In Maine it was under $200 per mile for an 18-ft. road previous to the war.

The scheme which has been outlined for extending the usefulness of gravel roads must not be misunderstood. It does not produce roads which are capable of standing the punishment of higher class roads. They are not adapted to heavy, all-the-year-round traffic, but they are adapted to a light winter traffic and during the summer will stand up under heavy touring traffic.

Where heavy winter and spring traffic exists, this type of road will not answer, and macadam, bituminous macadam, or even a more expensive type, will prove more economical.

If, however, the gravel road can be made to stand the traffic by an expenditure of even $1,000 to $1,200 per mile per year, it is justifiable, rather than to build a higher type at prevailing prices and high interest rates. A $20,000 per mile type costs yearly in the neighborhood of $2,500 for interest, depreciation and upkeep; and a $40,000 per mile type may be rated at $1,500 per year for the same charges.

---

*Abstract of a paper presented last month at the annual convention of the American Society for Municipal Improvements.

Provisions of Washington, D. C., Zoning Plan

On March 1, 1920, Congress passed an act providing for a zoning commission for the District of Columbia. The work was started on May 1, and the zoning plan was officially adopted on Aug. 30. The principal provisions of the plan were described by Mr. Harland Bartholomew, consultant to the commission, in a paper presented at the recent convention of the American Society for Municipal Improvements from which the matter following is abstracted.

Use Districts.—There are four use districts:

1. Residential district
2. First commercial district
3. Second commercial district
4. Industrial districts.

In the residential district buildings may be used for dwellings, apartment houses, hotels, churches, clubs, institutions, etc., farm and truck gardening, nurseries and greenhouses are also permitted as well as the excavation and removal of sand, gravel or clay; accessory buildings customary and incidental to the foregoing uses are also permitted, including a private garage containing not more than four automobiles. A public garage having no repair shop is also permitted in a residential district when complying with a very rigid consent rule heretofore adopted. It was deemed necessary to admit public garages to residential districts owing to their great area, the consent rule now in force having operated to prevent any unusual abuses of such a privilege. In this connection it is interesting to note a provision requiring that all garages located in residence districts be removed at least 30 ft. in case of private and 75 ft. in case of public garages from any street building-line.

In the first commercial district, which constitutes portions of the principal radial thoroughfares as well as a considerable section of the principal business district, buildings may be erected and property used for the usual types of retail stores and shops but excluding blacksmith, bottling works, cooperage, lumber-yard, livery stable, public garage and automobile repair shop (except when complying with the consent rule), stone-yard, junk-yard, uses excluded from the second commercial district and any kind of manufacturing other than the manufacture clearly incidental to a retail business conducted on the premises. Bakeries or laundries employing more than five persons, a milk distributing station or a public garage with only incidental repair facilities are permitted in the first commercial district upon written consent of the owners of 75 per cent of the property within a radius of 200 ft.

The second commercial district is greatly limited in area and usually confined to the property bordering railroads which is now used for or in the future would be unsuitable for any use other than manufacturing purposes. An extensive list of objectionable types of industries are excluded from the second commercial district.

In the industrial district buildings and premises may be used without restriction except those already imposed by law or municipal regulation. Industrial districts are greatly limited in area being confined to narrow belts along the railroads where heavy industries have already been built.

Height Districts.—There are four height districts as follows:

35-ft. height district
55-ft. height district
85-ft. height district
110-ft. height district

The 35-ft. height district embraces practically all one-family detached residential districts of Washington and the outlying suburban areas as yet undeveloped. In this district a one-family house may exceed 35 ft. height restriction by no more than 10 ft. by providing two side yards of 15 ft. each.

The 55-ft. height district contains those sections of the old city of Washington now occupied by 3 and 4 story houses and apartments.

The 85-ft. height district includes practically all of the wide streets within the old city limits, the higher value property surrounding the principal business district and the industrial areas.

The 110-ft. height district includes the principal down-town business district with such areas as this district will expand in.

For many years Washington has had a very detailed plan of regulating the height of buildings, depending in general upon the width of the street. With the exception of Pennsylvania Ave., upon which buildings 160 ft. high could be built, no building elsewhere in the District of Columbia could exceed 130 ft. in height and that only on streets 160 ft. wide within the business district specifically designated as business streets. There never seemed to have been any great reason for exceptional height on Pennsylvania Ave. and only comparatively few buildings within the business district have even taken advantage of the maximum height limitations of 130 ft. Considerable objection was voiced to a reduction in the height limit from 130 ft. to 110 ft., in fact the only real objection to the entire plan expressed at the hearings having been with regard to the reduction of height limit. After mature deliberation the Zoning Commission felt justified in establishing a 110-ft. height limit.

Area Districts.—There are four area districts as follows:

1. "A" area district
2. "B" area district
3. "C" area district
4. "D" area district

The "A" area district includes areas to be developed for detached and semi-detached homes. A rear yard and one side yard are required. Buildings may occupy 40 per cent of an interior lot and 50 per cent of a corner lot.

The "B" area district is intended primarily for areas which will develop with row houses and small apartments. A rear yard is required. Buildings may occupy 60 per cent of an interior lot and 70 per cent of a corner lot.

The "C" area districts are intended for areas to be developed with larger apartment houses and stores and shops in the first commercial district. Commercial buildings may occupy 100 per cent with the first floor, otherwise buildings shall not occupy in excess of 75 per cent of the interior lot nor in excess of 90 per cent of a corner lot.

The "D" area district includes the high value down-town business district, the second commercial district and the industrial district. A rear yard is required on interior lots above the first floor where lot occupancy of no more than 90 per cent is permitted.

For all tenements or apartment houses hereafter erected two side yards are required of dimensions complying with the district within which such tenement or apartment house is located.

In order to encourage a desirable type of the less expensive forms of group housing now becoming more or less prevalent, a proviso was added that the requirements of side and rear yards might be waived for a community house containing no more than three individual buildings where two side yards and a rear yard of not less than 10 ft. each were provided and otherwise complying with the area requirements of the district in which located.

Non-conforming uses existing at the time of the adoption of the zoning regulations are permitted to continue, but in accordance with the act of Congress no structural alterations may be made in non-conforming uses except such as may be required by law or regulation. No new buildings may be erected in connection with non-conforming use. The act of Congress is more specific and restrictive in this connection than any other zoning law or ordinance. It practically assures complete conformity with the zoning plan by all buildings within a reasonable period, i. e., the life of existing buildings.

One of the interesting features of the Washington work has been a definite determination of the district boundary line both for height, area and use of buildings and premises upon a set of real estate atlases secured especially for that purpose. While the zoning regulations and a set of maps will be published for general circulation, there nevertheless exists a final record of the exact boundaries of the districts in the determination of which many inaccuracies or inconsistencies were avoided, which undoubtedly would have occurred in a series of small-scale maps.

The Zoning Commission of Washington becomes under the act of Congress a continuing body. While the Commissioners of the District of Columbia are charged with enforcement of the zoning regulations, appeal from the action of the Commissioners of the District of Columbia may be taken to the Zoning Commission. Thus the Zoning Commission becomes in effect a Board of Appeals in whom also rests the power to initiate changes in the plan now adopted, either by their own motion or upon petition. Interesting in this respect is the provision in the Act of Congress that where a petition for a change in a district occurs which is not contiguous to a similar district, the owners of at least 70 per cent of a frontage within an area not less than blocks in length must join in such petition before it may be considered by the Zoning Commission.

Rules for Utilizing Old Macadam as Base for Bituminous Pavements

In a discussion Oct. 14 at the convention of the American Society for Municipal Improvements, Mr. George C. Warren, President of Warren Bros. Co., Boston, Mass., gave the following rules for the use of existing macadam as base for bituminous pavements:

Never depend on surface appearance nor even on test excavations made a few weeks or months before construction to determine whether or not the old macadam will require reinforcement.

Always make test holes or better test cuts across the street or road at intervals of, say, 100 ft. immediately in advance of construction and from those test observations come to an intelligent conclusion as to the necessity for a depth of new metal required to provide the necessary strength of base which will doubtless vary on different sections of the same project. The quantity of new metal, if any, cannot be definitely determined in advance. Consequently, such reinforcement should be paid for per ton or cubic yard of new material actually used and bids taken on that basis. It is wasteful to attempt to determine and specify in advance of construction how many, if any, inches of new metal is necessary over the entire road. Even if test excavations are made in advance of preparation of plans and specifications preparatory to letting a contract, traffic may very materially change the condition before the construction period has arrived.

Do not disturb the old macadam for change of grade or contour or by scarifying unless absolutely necessary. Any such disturbance more or less reduces the strength and consequently the conservation value of the old macadam and sometimes actually removes practically all of it in the center of the road.

If the crown is excessively high, better correct by building up the quarters and outer edges with new metal than to remove solid road metal from the center unless there is a greater depth of solid macadam in the center than is necessary.

In every case where there is any road metal on the street, however thin or weak it may be, it is better to leave it in place and conserve it for "all it is worth" than to remove it, especially in these times of high cost of labor and materials.

If such test excavation as recommended above develops 6 in. or more of solid metal (whether gravel or crushed stone) in which the coarse particles (ranging from ¼ in. to 2 in. or more in size) are more than ½ the total metal so that the finer particles merely fill the voids, then no treatment is necessary nor advisable except to regulate the grade, "knocking off" the high and filling up the low places by scarifying, picks in the roller, or hand picks, as may be most economical in each case, and then thoroughly roll the thus "prepared base."

If such tests show that the fine particles predominate, or the depth is insufficient on the whole or any part of the macadam road or street that condition does not justify excavation and wasting of the material; just add to the old surface after regulating its grade, whatever depth of new metal intelligent consideration of all the conditions indicates is best and safe. It will surely be much less labor and much less costly than to remove the old metal and supply an entirely new base.

If the drainage is poor, it should be corrected. A greater depth or more rigid type of base does not correct faulty drainage. On the other hand, faulty drainage can be corrected at much lower cost than by destroying the old macadam and furnishing new foundation.

Tree Planting Along California Highways.—A committee has been appointed to consider a system of tree and shrub planting along the state highway system of California.

Present Tendency in Street Lighting

The present trend in street lighting and illumination was outlined as follows in the report of the Committee on Street Lighting submitted last month at the annual convention of the American Society for Municipal Improvements:

There is a tendency in the larger cities to install on the principal thoroughfare, or thoroughfares, usually the main thoroughfare of the city, what is known as high power lamps, either the gas filled, or, in exceptional cases, the luminous arc.

New installations have just been made on Broadway in the city of Los Angeles, at Saratoga Springs, N. Y., at New Orleans and at San Francisco. These installations are composed of ornamental iron poles carrying one or more lamps at the top. Considerable height has been added to the poles, in some cases 27 ft., in contrast with lower candlepower units installed heretofore.

There is a tendency to substitute for residential lighting a lantern neatly designed to replace the round globe which has been so extensively used heretofore. There is an advantage in the lantern in that when a glass becomes broken it is not as expensive as the replacement of the globe. As an illustration: an 8x18 globe cost at this time approximately $7.50, the 8x16 nearly $5. Therefore it is easily seen that the replacement of one or two panels in a lantern is much less expensive and, furthermore, the lantern is a change and when of proper design is very artistic.

Greater effort is being put forth in designing street lighting systems artistically. This refers to the standards as well as the lamp equipment. In former years our street lighting systems were anything but artistic, and some of them very cumbersome and unsightly. These are all giving way to the more modern artistically designed equipment.

Practically all street lighting heretofore has been on the series system. There is a tendency, however, to install multiple systems. The thing that stands in the way of the increased use of the multiple system is the problem of controlling the system, i. e., turning the lights on and off in a way that will not only be economical but dependable. The constant-potential multiple system with proper control offers considerable advantage over the old constant-current series system. It has greater flexibility in the number of lamps, the elimination of station apparatus, taking advantage of the use of constant-potential transformers already in service for commercial purposes, power factor practically unity. It seems that the tendency will be for an increased extension of constant-potential multiple systems except where special systems are required for white-way lighting.

The practice on the part of municipal officials today is to spend more money for street illumination. In this connection often comparison as to the cost of street lighting on the per capita basis is made, but it does not tell the whole story. The true comparison is the number of watts per mile of street or the candle-power per mile of street. Then, too, the rate paid for electrical energy must be taken into consideration.

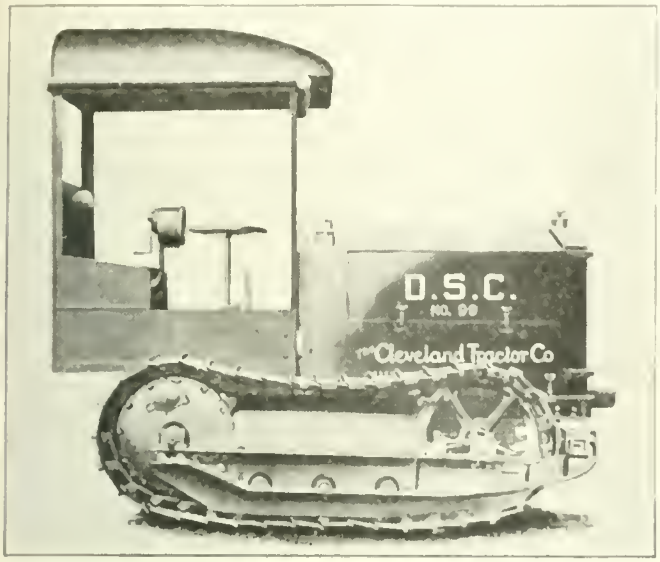
The tendency in the past has been to illuminate one downtown street, or the business section and leave the residential section unprotected. There is a clamor for electric street illumination to replace the inadequate gas lighting of the past age. Changes are being made as fast as the old contracts expire. It is difficult for gas illumination to compete with first-class electric street illumination.

In changing over street-lighting systems from gas to electric, in many cases the old iron lamp-post can be used by substituting a neat and artistic top casting carrying the necessary socket, receptacles and glassware. This will save considerable expense in the installation of an ornamental street-lighting system in a residential section in the replacement of gas lighting. This has been done in Chicago with good effect.

More money is being appropriated for street lighting than in the past because of the fact that it is now realized that a well-lighted thoroughfare is a great aid to the protection of the inhabitants of our cities, a great aid to the police department and fire department and furthermore, greatly adds to the safety in these days of the advanced use of motor-propelled vehicles.

Tractors for Snow Removal Work in New York City

As a means for preventing traffic tie-ups due to unexpected blizzards, such as the one of last February, which cost the merchants of New York City $60,000,000, and the city itself $5,500,000 for emergency snow removal, and the city itself purchased much new snow removal equipment. This includes 100 small tank type tractors, 50 large crawler type tractors, and a big fleet of trucks with dump bodies, together with the necessary push plows for the tractors. The order for the 100 small tank-type tractors was awarded to The Cleveland Tractor Co. of Cleveland, O., which will supply standard Cletracs equipped with winter tracks, a covered cab, a two-man seat, storm curtains and sirens. These tractors will be painted the characteristic buff and red of the New York Street Cleaning and Fire Departments. They will be delivered in December.



Small Tractor for Snow Removal Work.

County Replaces Teams and Slip Scrapers with Power Scraper for Excavating Gravel

A mechanically operated drag scraper at the gravel pit of the Cass County Road Commission, near Cassopolis, Mich., is accomplishing the work of half a dozen teams in excavating and handling gravel, according to D. P. Smith, road superintendent of Cass County.

The equipment consists of a ⅓ cu. yd. Sauerman bottomless power scraper operated by a Clyde 6¼x8 double cylinder, double drum steam hoisting engine, a "Good Roads" portable screening plant, a No. 10 Fort Wayne jaw crusher, and a traction engine that furnishes power for driving the crusher, the screens and the bucket elevator that raises the sand and gravel from the crusher to the top of the screening plant.

View of Cass County Gravel Pit, Showing Power Scraper Near Top of Incline.

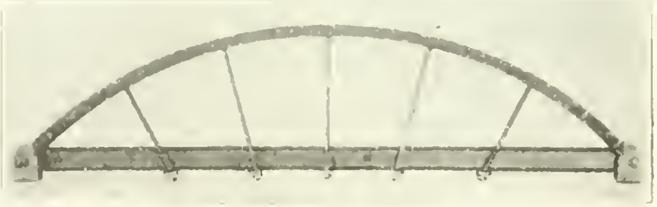
The gravel deposit is in a ridge running back from the main highway a distance of about ½ mile. Teams and slip scrapers had been used for several seasons in conjunction with the portable screening plant and had cut down the end of the ridge for a distance of some 30 ft. back from the road. When the power scraper was purchased in July, 1920, the screening outfit which had been stationed at the side of the road, was moved down into the center of the pit and located as shown in the illustration, while the scraper was installed so it could cut straight back into the nose of the ridge for a distance of 150 ft. and drag the excavated material to a short wooden incline alongside the screening plant. The method of operation is simple. When the scraper reaches the top of the wooden incline the load drops through a grated opening to the crusher and then to the boot of the bucket elevator. As the scraper is bottomless the dumping action is automatic and the hoist operator merely has to disengage the front drum operating the "load" cable attached to the front chains of the scraper and thrown in the friction of the rear drum operating the "pull back" cable and the scraper is on its way back for another load.

In its first two months of operation the power scraper opened a new cut about 20 ft. wide and 30 ft. deep for a distance of about 100 ft. into the gravel ridge. During this period, it moved an average daily yardage of 125 cu. yd. According to Mr. Henry Secor, foreman of the gravel pit, the plant only has to be operated on a half time basis to produce this output and could easily excavate and convey 250 cu. yd. per day.

The cost of excavating and conveying 125 cu. yd. per day with the power scraper has averaged $11.00, including coal, oil, water, light repairs and the wages of the engineer, who also acts as fireman. Before the power equipment was installed, the county was paying $40.00 per day to excavate 100 cu. yd., employing four teams and slip scoops and two extra laborers.

New Bridge Span for Highways

A new bridge span of simple construction, designed particularly for highway needs, has just been placed on the market. The essential features of the structure are two I-beam girders with shoes, and two channel arcs shaped in factory and shipped to field ready for assembling. In assembling no skilled labor is required. All that is necessary is to place the I-beams on the abutments, raise the channel arcs with a gin pole and drop the stress rods into place. The only tools required for this work are two wrenches and a crow bar. It is stated that three men can put in place and assemble one of these structures in three days. The bridges are built in sizes for any span up to 80 ft. For the latter span, the structure is designed to carry a load of 25 tons. The span was invented and patented by Mr. J. W. Lee, an engineer experienced in highway building and maintenance. It is sold by the Pan-American Road Machinery Co., 907 Rector Building, Chicago, of which Mr. Lee is president.



The Simplex Bridge Span.

Committee of Manufacturers to Co-operate with American Road Builders' Association. Representatives of 15 industries identified with highway construction held a meeting at The Automobile Club of America Oct. 22nd. The purpose of the meeting was to complete the organization of an advisory committee of manufacturers to co-operate with the American Road Builders' Association in holding a great exposition of highway equipment and materials in connection with the association's annual convention, which will be held at the Coliseum, Chicago, during the week of Feb. 7th next. The industries represented at the forthcoming exposition will include the sand and gravel industry; crushed stone; portland cement; asphalt and oil; tar; granite block; paving brick; slag, road building machinery; quarrying machinery; excavating machinery, trucks., tractors and trailers; concrete mixers; engineering instruments and explosives. It was developed at the meeting that upwards of one billion dollars is annually available for highway and street work and that a genuine necessity exists for capacity production and distribution of highway materials and equipment. An executive committee to represent the producers and manufacturers was appointed, consisting of J. E. Pennybacker, of the Asphalt Association; R. H. Wait, of the Portland Cement Association, W. T. Chollar, of the Lakewood Engineering Co.; D. C. Fenner, of the International Motor Truck Co., and P. P. Sharples, of The Barrett Company. A Chicago committee was also appointed, with S. F. Beatty, of the Austin Western Road Machinery Co., as chairman.

Road Grading with Land Leveler and Tractor

By J. L. COCKRELL.

The land leveler, a dirt-moving machine used extensively in the Western states, but comparatively unknown in this section of the country, is being used by Mr. W. M. Spencer, a contractor of Liberty, Mo., in road grading.

When the writer was observing the operations, they were grading a road through a country where the land was very hilly and these succession of small hills had to be cut down and the dirt moved into the depressions in order to bring the road to the required grades. Usually the dirt had to be moved from 100 to 300 ft., the average being about 200 ft. The "Caterpillar" outfit was moving dirt two ways; that is, going over the hill and loading at the crest and dumping in the depression on the far side, and on the return trip the dirt was moved to the depression on the opposite side of the hill. This made one leveler full of dirt delivered for each turn made, and the total travel for each load of dirt 400 ft. The dirt moved per load was estimated at 4 yd., and the time per load was 8 minutes, including turns. This figures ½ yd. per minute or 300 yd. per 10-hour day.

Road Grading With Land Leveler.

Two men are all that are necessary to operate this outfit. It loads in ordinary clay without plowing and the dirt is placed where needed and may be spread out thin and evenly or all dumped within 5 or 6 ft. of travel.

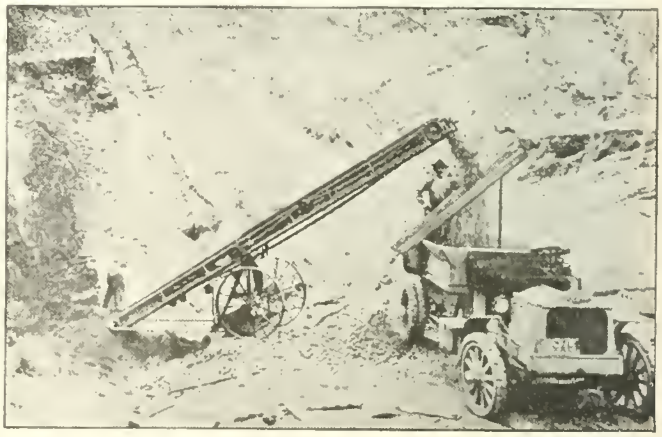
The operator on the leveler can place the whole weight of the machine, which is about 5,000 lb., on the cutting blade. The leveler is equipped with a power lift which may be controlled in such a way that the dirt can be placed as desired by the operator. Part of the dirt may be released and then the blade dropped again and the balance of the dirt released at another point.

This work was being done with a 10-ton "Caterpillar" tractor and land leveler. The Holt Manufacturing Co., Peoria, Ill., also builds a land leveler of suitable size for the 5-ton "Caterpillar."

Control of Shifting Sand on Roads by Oiling. Shifting sand dunes which cover up a highway soon after it is completed have formed a serious obstacle to improved road building in some parts of the country, particularly in the Northwest. To remedy the evil, the Bureau of Public Roads of the United States Department of Agriculture has been employing oiling methods extensively. Fifty-three miles of construction of the Columbia River highway from The Dalles eastward lies through sandy country, in many places of a volcanic ash as light as flour. As fast as cuts are opened up and fills made in this light soil the wind whips out the fill slopes and sand dunes creep into rock cuts, completely blocking the road. Oil is the only agency yet found to stop the trouble. The equipment used to spray the crude oil consists of two supply tanks, or drums, in which the oil is carried from the storage tank at the railway siding, and a tractor, which draws the oiling rig and supplies the steam through a hose to the compressor tank, which is carried on a trailer. The oil is heated by the steam and forced through a hose with a nozzle consisting of a half-inch pipe. The steam atomizes the oil and sends it in a fine spray for 100 ft. or more, depending or whether the spray is projected in the direction of the wind or against it. For obvious reasons, spraying is usually carried on in the direction of the wind. Where sufficient oil is used, this means of controlling the sand dunes is very effective, and it is believed that the cost will not be excessive, though exact figures are not obtainable at this time.

Loading and Screening Sand With Scoop Conveyor

The installation shown in the accompanying illustration is employed at the sand pit of Somers & Sons, Wyoming, Pa. The screen is supported by a pole and on the edge of the truck by a small block of wood. The 24-ft. scoop conveyor is placed so that the material, when discharged, would fall near the top of the screen. The screen being set at proper angle the large lumps rolled off out of the truck while the fines fell through. With this arrangement it is stated that 5 tons of sand can be loaded and screened in 7 minutes.



Loading and Screening Arrangement at Wyoming, Pa., Sand Pit.

Personals

Forest Lake, Sanford, Fla., has been appointed member of the State Road Department of Florida.

A. M. Green, at present county surveyor of Modoc County, California, has been appointed county engineer.

J. B. Crockett has resigned as county engineer of Collins County, Texas, and will engage in contracting. He is succeeded by E. P. Asbury.

C. C. Boyer of Bishop, Cal., formerly connected with the California department of highways, has been made district engineer of the Nevada highway department with headquarters at Las Vegas. He succeeds C. E. Benson, who resigned some time ago to enter another line of business.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Tarvia.—The Barrett Co., New York City. 48 page booklet describing the various uses of tarvia in road work.

Snow Removal Equipment.—Baker Manufacturing Co., Springfield, Ill. 12 page catalog of snow moving equipment, including auto truck and horse drawn snow plows.

Tractors.—Holt Manufacturing Co., Peoria, Ill. Bulletin regarding application of "Caterpillar" tractors to transportation purposes for various industries. Contains specific cost data and operating information.

Vitrified Clay Pipe Culverts.—Clay Products Association, 133 W. Washington St., Chicago, Ill. 22 page booklet containing standard specifications and working drawings, tables of quantities, capacities, strengths, etc.

Road Building Equipment.—Lakewood Engineering Co., Cleveland, O. 32 page booklet describing the concrete road building plant featured by this company. Contains descriptions of the various units making up this plant and their use.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 403 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00; any one monthly issue 50c. Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., NOVEMBER 10, 1920. Number 19.

Two Kinds of Logic

Ninety years ago Sir John Herschel, a celebrated astronomer, wrote a little book entitled, "The Study of Natural Philosophy." It was this book that not only suggested to John Stuart Mill the idea of formulating his "canons of induction" but furnished him with all that is novel in his treatment of the subject of induction. Were it not for one paragraph in his Logic, Mill might be charged with having stolen his entire inductive logic from Herschel. Speaking of Herschel's book Mill says:

> Our third example shall be taken from Sir John Herschel's Discourse on the Study of Natural Philosophy, a work replete with happily selected exemplifications of inductive processes from almost every department of physical science, and in which alone, of all books which I have met with, the four methods of induction are distinctly recognized, though not so clearly characterized and defined, nor their correlation so freely shown, as has appeared to me desirable.

Thus Mill gives scant credit to the man to whom he really owes nearly all that is of value in his discussion of inductive logic.

Herschel speaks of logic as being of two kinds: (1) Verbal logic and (2) Rational logic. The former is the Aristotolean logic or the "logic of the schools." The latter is:

> that higher kind of logic, which teaches us to use our reason in the most advantageous manner for the discovery of truth, which points out the criterions by which we may be sure we have attained it, and which, by detecting the sources of error, and exposing the haunts where fallacies are apt to lurk, at once warns us of their danger, and shows us how to avoid them. This greater logic may be termed rational, while, to that inferior department which is conversant with words alone, the epithet verbal may, for distinction be applied.

Verbal logic was introduced by Aristotle, himself a grammarian before he became "the father of logic." Herschel properly designates it as an "inferior department" of logic. Had Herschel called his book "The Principles of Inductive Logic," or "A Treatise on Rational Logic," or "Experimental Logic," or any other name in which the word logic was given prominence, there is little doubt that to Herschel and not to Mill would have been assigned the credit of having been the first to depart from the traditions of "the schoolmen" in producing a book on the science of reasoning. But so great is the inertia of an established belief that there is scant hope now that Herschel's book will be generally elevated to the eminence that it deserves. The book has long been out of print, whereas Mill's inferior treatise is still to be had in up-to-date apparel.

The difference between a scientific training and a linguistic training is well illustrated in the works of these two men. Herschel clothes his ideas in clear language, made still more lucid by the frequent use of illustrative examples. Mill delights in Latinic words, the more technical the better, the meaning of which he seldom takes the pains to define. Although pre-eminently a verbalist, Mill seems to scorn the task of defining the words he uses; or, having defined them, is careless about adhering to the definitions. Thus he speaks of "law" as being "a uniformity of nature," only to say later on that "laws" may be counteracted—in other words, may cease to be a uniformity. We quote:

> For there is probably no one even of the best established laws of causation which is not sometimes counteracted.

A natural law is never counteracted, but a force (or cause) may be. Mill repeatedly confuses "law" with "force"—a thing that Herschel never does. The reason for Herschel's carefulness in the use of words is probably to be found in his training as an astronomer and chemist. The man who becomes habituated to use instruments and reagents with precision usually needs but little practice in words before he comes to use them also with precision. But the man who has never been accustomed to physical exactitude is usually as careless in his language as he is in his observations and his actions. There is, however, grave danger that the scientific man will not see that language is itself an instrument, one without which complex thinking is almost impossible. Hence it is a mistake to belittle the Aristotolean logic even though it be "inferior" to Baconian logic. Nor did Herschel belittle verbal logic.

Illustrative of the influence of an excessive training in linguistics is Mill's evident belief that he has converted Herschel's "rules for the discovery of truth" into "canons of inductive proof." Looking behind the words to the acts that they are intended to explain, there is not a particle of difference between one of Mill's "cnnons" and one of Herschel's "rules." But to a language loving mind, like that of a Mill or a Bain, if the words are sufficiently changed the acts seem also to be changed. So Bain says:

> It was the distinction of Mr. Mill's handling of Logic to draw a clear and broad line between the Art and Science of Proof and the Art of Discovery. The main business of Logic according to him is the proving of propositions; only in an incidental way does it aid in suggesting them.

To quote Mill himself:

> Logic does not undertake to find evidence, but to determine whether it has been found. Logic neither observes, nor invents, nor discovers; but judges.

It is scarcely to be wondered that so narrow a view as to the province of logic has all but killed it as a special science. Herschel's treatment of logic is, on the other hand, inspiring. The pity is that he did not give to his book a title that would have been a challenge to the entire school of verbalistic logicians. What a rattling in scholastic tombs there would have been had Herschel called his book Rational Logic or the Science of Discovery.

What Do You Spend for Technical Advancement?

Two book publishers produce nearly all (probably 90 per cent) of the technical books sold in this country. One of these two publishers is the owner of 11 technical periodicals. From a recent statement by one of the managers of that book company it appears that four books are sold annually for every subscriber to the eleven periodicals. This does not mean, either that the subscribers buy only from the book publisher, or that the book publisher sells books only to those subscribers. It seems probable, therefore, that the average technical man buys fewer than four books annually —probably not more than two or three. This leads to the conclusion that the average technical man spends not more than $10 a year for technical books.

At first sight this seems like a considerable sum to invest annually in books of an educational nature; but is it? Is three cents a day an adequate outlay for technical books? It is true that another five cents daily may be the average expenditure for technical society membership and for subscription to technical periodicals. But even if the average total expenditure for technical self-culture is 10 ct. daily, is it adequate? Doubtless the average daily expenditure of the same men for tobacco is twice 10 ct. Doubtless the average daily income of these men exceeds 1,000 ct. Is the expenditure of 1 per cent of one's daily income for technical education and co-operative effort an adequate expenditure?

Hoover Endorses the Federated American Engineering Societies

Herbert C. Hoover, President of the American Institute of Mining and Metallurgical Engineers, has recently made the following statement about the Federated American Engineering Societies:

The time has arrived in our national development when we must have a definite national program in the development of our great engineering problems, all of which cry for some broad-visioned national guidance. We must create a national engineering sense of provision for the nation as a whole. If we are to develop this national sense of engineering and its relations to our great human problems, it must receive the advocacy of such institutions as this. The Federated American Engineering Societies, composed of the various engineering societies, represent the engineers of the United States.

It is our duty as citizens to give voice to those critical matters of national policy which our daily contact with this, the fundamentally constructive profession, illuminates to us. Just as our medical associations voice the necessity of safeguards to national health; as the bar associations offer safeguards to our judiciary, so the engineers should exert themselves in our national engineering policies. We have none; but we need some, or the next generation will face a lower instead of a higher standard of living than ours.

Individual initiative is insufficient because the problems involve political, financial, interstate matters beyond individual ability. The problems involved are beyond individual initiative alone. We must have a national conception and national guidance. Co-operation by united effort instead of parrallel effort not only promises greater good to the profession but seems to be the unanimous will of the engineering profession of the country as evidenced by the June convention in Washington and the subsequent action of the engineering societies throughout the country.

The Federated American Engineering Societies is of such portent that it seems to me real co-operation can be accomplished in full measure only by membership in it and that only by such combined action can we secure the measure of public service we all desire.

The object of this organization as stated in the Constitution is to further the public welfare wherever technical knowledge and engineering experience are involved, and to consider and act upon matters of common concern to the engineering and allied technical professions.

Here is the opportunity for the engineering profession to show its solidarity and accept this opportunity of performing its duty to the nation which rests upon the profession as a whole and cannot be performed by any component part in an individualistic effort.

Advantages of Meterage.—An interesting little note setting forth the advantages of metering water services appears in the 1919 report of the Water Department of Charleston, S. C. We quote as follows:

Too much importance cannot be given to the matter of metering the water to customers. In first place, in a municipally owned plant, in which all of the citizens are interested, it makes everyone pay for the water used by them, and therefore, throws no burden on any one. In the next place, it is gradually making for better plumbing and more attention being given to the water supply by each one of our customers. Metering has meant the saving of a water famine in our city. It has converted an unprofitable rundown plant into a profitable, gradually improved efficient one, with no nardship on any one who uses, but does not waste the water. It would be utterly impossible for the Commission, with the present perfectly adequate water supply to the needs and uses of the town metered, to supply enough water to the city were it not for the meters.

According to the report, on Dec. 31, 1919, the water services of Charleston were 92.2 per cent metered, and it was hoped during the coming year to meter the 649 taps remaining on the flat rate. J. E. Gibson is Manager and Engineer of the Water Department.

Peat Blocks for Fuel in Baltic States.—So serious is the fuel situation in the Baltic States that the Government of Latvia is considering the issuing of wood and peat cards in much the same manner as the other governments of Europe issued, during the war, bread, sugar and milk cards. As a result of this threatened fuel shortage the Latvian Government has turned its attention to the harvesting of the vast peat deposits which are to be found about Riga, in the country around Kovno, and in other sections. Already the peat market in Riga is one of the interesting spots in the city, while the gathering and preparing of it is furnishing employment for scores of men and women.

In this attempt to educate the people in the use of peat, the various stations of the American Red Cross are setting an example by using it for cooking purposes. At the same time Red Cross officers are conducting experiments with a combination of peat and other materials in an endeavor to find a fuel which may be used in the manufacturing plants about Riga and thereby reduce the drain on the wood supply of the country.

Construction to Start on Illinois Waterway.—The Illinois Department of Public Works has awarded the contract for the first of the six locks for the new Illinois project, which will open 63 miles of waterway between the Illinois River at the Drainage Canal of the Sanitary District of Chicago. The lock will be built at Marseilles, and the contract price is $1,373,115. Bids for the second lock will be opened Nov. 23.

An Economic Electrical Pumping Plant at Delphi, Indiana

By G. C. BLALOCK,
Asst. Prof. of Electrical Engineering, Purdue University.

Prominent among the many municipalities in the State of Indiana which have recently elected to change their pumping stations from steam to automatic electric operation is the city of Delphi. This change was effected in July, 1919, without interruption to service, and successful operation has proceeded since then at a very marked reduction in operating expense.

The equipment, furnished by the Hill Pump Company of Anderson, Ind., and installed under the supervision of Charles Brossman of Indianapolis, consists of two 4-in., two-stage, centrifugal service pumps, driven by 30 hp. squirrel cage induction motors, and a 6-in. six stage centrifugal fire pump, arranged for drive by 75 hp. motor or by an automobile-type gasoline engine of corresponding capacity, the motor and engine being mounted for driving through clutches from opposite ends of the same shaft. The service pumps are rated at 400 gals. per min. each against a head of 140 ft., while the fire pump has a capacity of 800 gals. per min. against a head of 231 ft.

The service pumps are used alternately, the capacity of one unit being sufficient to supply the normal demand. This unit is automatically brought into operation when the pressure drops to 50 lbs. and is shut down at 60 lbs.

The water supply flows through a 10-in. pipe by gravity from springs located three miles away and empties into an underground reservoir at the station. The discharge goes directly from the pumps into the mains and into an elevated storage tank, which may be cut off in case of fire and the pressure raised by bringing the 6-in. unit into operation.

Power for driving the motor is secured from a transmission line which passes through the town and is delivered at 2,200 volts, 25 cycles 3-phase, and stepped down at the station to 220 volts.

Pump Tests.—The matter of testing the pumps presented some difficulty because of the lack of suitable means for measuring the output. No means was available for shutting off the flow of water to the mains while pumping to the elevated tank, nor was it found possible to cut off entirely the flow of water from the springs into the intake reservoir. So it was necessary to devise an indirect method for making the test. The method adopted, while admittedly subject to error, permitted determinations which give at least a general idea of the station duty and efficiency. It is to be recommended in all cases of electric operation that a meter be provided on the discharge side of the station, to be used in conjunction with the electric meters commonly provided on the motor intake, for checking station duty and efficiency at frequent intervals.

The motors were first disconnected from the pumps and given locked-rotor and no-load tests. The necessary resistance was inserted in the main circuit back of the switchboard by means of water rheostats constructed from oil barrels, with old boiler tubing for electrodes. The resistance of the windings was measured by use of the storage batteries provided for starting the gasoline engine. With the data thus obtained circle diagrams were plotted and performance curves of the motors determined in the usual manner. These curves showed the motor performance to be up to common requirements.

For determining differences in water level in the elevated tank a float was arranged, with line extending over a pulley at the top of the tank, and thence to a scale near the ground. The differences in elevation could thus be read to fractions of an inch and this method therefore provided a much more accurate measure of water entering or leaving the tank during a given period than could have been obtained by depending upon pressure gauge readings, since the gauge did not read nearer than 2 lbs. per sq. in., corresponding to a head of about 4.5 ft. A calibration curve between scale and pressure gauge readings was plotted for assistance in obtaining accurate readings of total head when the pump was in operation.

For the 24-hr. period during which the test was conducted scale and pressure gauge readings were taken at intervals varying from 5 mins., during the periods of greatest demand to 30 mins., during the period from midnight to early morning. Pump operation was limited to comparatively short intervals and during these periods of operation readings were also taken of voltage, current, power input, speed, and vacuum at 5 min. intervals. A demand curve for the 24-hr period was plotted and by assuming the demand during a given interval of pump operation to remain constant at the average value found for the preceding interval of shut down, it was possible to calculate the discharge. That is, assuming an average outflow from the pump to the mains as determined from the demand curve, the excess of pump discharge over consumption entered the standpipe; and the pump discharge was equal to the sum of the quantity consumed and the quantity entering the standpipe. Then, since the total head against which the pump operated, as well as the power input, was known, the duty and efficiency could be readily calculated.

Test Results.—An average of 12 runs indicated that the motors were operating at 15 to 20 per cent less than their full load rating, which, however, did not materially reduce their efficiency as indicated by the circle diagram. This characteristic is more advantageous than otherwise since it enables the pump to discharge at a higher rate in case of abnormal demand without endangering the motor.

The over-all plant efficiency proved to be slightly less than 40 per cent, which is a fair figure for a plant of this size. This results in a pumping duty of 1.25 kw.-hrs. per 1,000 gals. or 0.86 kw.-hrs. per 1,000 gals. per 100 ft. head, which is better than the average duty for small town plants over the state. (See Bul. No. 1, Engineering Experiment Station, Purdue University, Electric Driven Waterworks in Indiana.)

The average demand for the 24-hr. period was found to be 73 gals. per min., corresponding to a total consumption for the day of 105,000 gals., while estimates based on the station chart show that for a period of 13 days preceding the test period the average water pumped per day was 94,500 gals., a per capita consumption of 43 gals.

Electric Energy Consumption.—Records of meter readings for the first year of operation are given below. The periods between meter readings do not correspond exactly to the time shown, but serve to give a general idea of the distribution through the twelve-month period.

1919		1920	
Month.	Kilowatt-hours.	Month.	Kilowatt-hours.
July	1,680	January	2,976
August	2,124	February	2,976
September	2,421	March	2,724
October	2,364	April	2,880
November	1,944	May	2,568
December	2,628	June	2,364

Total energy consumed during the year = 29,652 kilowatt-hours.

Average anergy consumption per month = 2,471 kilowatt-hours.

The above records indicate either that the amount of water pumped during the test period was abnormally high or that the plant is operating at even better efficiency than shown by the test figures. An average of 2,471 kilowatt-hours per month, at the test figure of 1.25 kilowatt-hours per 1,000 gals., would indicate an average daily pumpage of about 65,000 gals., or 30 gals. per capita.

Operating Costs.—Comparison of operating costs for the last year of steam operation and the first year of electric operation show a very marked difference in favor of the electrical equipment. From July, 1918, to July, 1919, under steam operation, expenses were as follows:

Labor	$1,745.96
Fuel	1,899.78
Supplies	196.15
Maintenance	57.41
Total	$3,899.30

From July, 1919, to July, 1920, with electric operation, the expenses were:

Labor	$ 3.00
Electricity	666.86
Gasoline	107.06
Supplies	107.40
Maintenance	51.81
Total	$ 936.13

Thus electric operation is shown to result in a saving of 76 per cent in total operating expense, a result little short of startling. And if we consider cost of steam operation during the calendar year of 1918, the result is even more pronounced, since the operating expenses for this year mounted to a total of $4,821. It must be kept in mind, of course, that charges for electric energy have not kept pace with the rising costs of fuel and labor and that when a stable price level is again reached the difference between operating costs by steam and electricity will not be so pronounced as indicated by the figures here given. But it seems not too much to expect that electrical equipment, intelligently selected and properly installed, may be depended upon at all times to result in a saving of 25 per cent to 50 per cent in operating expense of pumping stations serving a population less than 10,000. For larger populations it is hardly safe to draw general conclusions at the present time.

Some Points Learned in Operating the Columbus Garbage Disposal Plant*

By WALTER D. BEE,
Superintendent, Division of Garbage Disposal, Columbus, Ohio.

The garbage at the Columbus plant is first cooked with live steam, then pressed through continuous roller presses. Tank liquor from the presses goes to the grease separating tanks and from these to storage. The tank liquor is drawn from storage as needed and passed through vacuum evaporators. Solids from the roller presses go through the first dryer, and then to the percolator for final de-greasing with gasoline. After percolating, the tankage is mixed with all the stick liquor it will hold, and again dried, the final operation being sizing and grinding.

Drying the Tankage.—The first point to be covered is the manner of drying the tankage so as to produce a merchantable article. At the Columbus plant the tankage is dried twice. As it comes from the presses the tankage contains from 65 per cent to 75 per cent of moisture. This moisture content is reduced in the first drying to about 10 per cent or 12 per cent, or dry enough for the material to be "wetted" with gasoline.

After final de-greasing with gasoline as the solvent, the tankage is passed over a ½-in. mesh screen, all material too large to go through the openings being rejected as of no further value. That which goes through the screen is then conveyed to the mixer where enough stick liquor is added to make the mixture so thin that it will "run" rather than "pile up." This makes a pretty wet product to dry in one operation, but we do it in a direct heat dryer, and the tankage comes out as a hard granular substance with an average of about 3 per cent moisture.

It has been our experience that the mixing is the particular place where both the quality and the weight of the finished tankage may be most easily influenced. The more stick that can be added, the better and heavier will be the resulting tankage. The average annual analysis of Columbus tankake runs about 3¾ per cent ammonia, 1 per cent potash, and 7½ bone phosphate, and we receive very few dead animals to help boost the ammonia.

Since learning the importance of the stick in the finished product, we have been able to command a better market at a much higher price than is obtained for other tankages which have not been so carefully manufactured. In fact, we are at present getting almost as much per unit as is being paid for high-grade animal tankage.

Solvents and Their Recovery.—The second point to be discussed is that of solvents and their recovery. Gasoline has always been used at the Columbus plant, and up to the time this country entered the war, there was no particular difficulty in securing the grade desired. During the war, however, we had to take what we could get and be glad we got it. The result being that there was considerable loss of solvent due to high boiling points.

Last year and this, we have been able to get a good grade of gasoline by carefully specifying what we wanted and then distilling a sample from the car, to see if it was up to specifications. Several cars have, during the last 10 years, been rejected and turned back to the refiners because of high end points. As our power plant operates at 115-lb. steam pressure without superheat, we are limited in the temperature we can obtain in the percolator, when "steaming out."

We specify a straight-run gasoline which will distill off at least 95% at 300° F., and then watch the car sample to see that the distillate comes off reasonably uniform. Ordinary motor car gasoline does not distill readily with steam, and in addition is not nearly so good a grease solvent as the "high test" variety. Our loss of solvent averages a little more than one gallon per ton of garbage treated, and has varied considerably from year to year, due to condition of plant and grade of gasoline used.

Quantity and Quality of Garbage.—As a last point for discussion, I believe a short review of general garbage conditions during the last ten years in Columbus, will be of interest and show to what extent the people responded to the appeal to conserve food during the war.

Up to, and including 1916, the City collected garbage once a week during cool weather, and twice a week through July, August, and September. Beginning with the year 1911, the garbage increased from 190 lbs. per capita, to 218 lbs. in 1915. In 1916, the last year of twice-a-week summer collections, the decrease started with 203 lbs. per capita. Since 1916, collections have been on a weekly schedule throughout the year, and the slump continued to 1918 with a per capita of 138 lbs. Last year showed an increase to 157 lbs., and this year promises to add a further substantial increase.

That the quality of garbage is best indicated by its grease content, is shown by the fact that we have been able to hold the tankage production almost uniformly at a bit more than 10% of the green garbage weight. We feel that the quantity of tankage that can be produced from a ton of garbage depends more upon the care and completeness of manufacture than on the richness of the garbage.

Taking this fact as a basis, I do not believe that the quality of the garbage varied much from year to year, until 1916, when wages had advanced considerably, but commodity prices had not, as yet, gone up in proportion. Previous to 1916, grease recoveries were fairly uniform at about 2½%. In 1916 more than 3% of grease was obtained. Since then, grease recoveries have decreased until last year less than 2% was produced. So far this year the quantity of grease secured indicates that the low point was reached in 1919, and with a further decline in the price of food, the grease content or richness of the garbage should slowly increase.

---

*A paper read before the American Society for Municipal Improvement.

Operation of Fitchburg, Mass., Sewage Disposal Plant in 1919

The total cost of operation and maintenance for the year 1919 of the Fitchburg, Mass., sewage disposal plant was $9.56 per million gallons, according to the annual report of the Department of Public Works. The following data from this report are of interest.

During the year the grit chamber removed 223.9 cu. yd. of screenings. The Imhoff tanks treated an average of 3,351,380 gal. per day, with a computed period of detention of 6.0 hours average, 3.8 hours minimum, and 20 hours maximum. The annual average removal of settleable solids was 98.04 per cent, of suspended matter 66.5 per cent, and a total of 823.7 tons of dry solids. The flow was reversed each month. Grease and scum accumulations amounted to 18.8 cu. yd. and were removed three times a week. Two of the Imhoff tanks were cleaned for the first time since the beginning of the operation.

The trickling filters treated 3,336,000 gal. per day, or 2,960,000 gal. per acre per day on an average for the year. There was no appreciable trouble with clogging. 22.2 nozzles or 8.4 per cent of the total were cleaned on an average each day. Unloading began in April and continued through May.

The secondary tanks removed 360,078 gal. of sludge with 93.28 tons of dry solids during the year. Of this amount, 243,502 gal. were returned to the Imhoff tanks for digestion.

Sludge was disposed of on sludge beds and by filling in low areas. On the former 499,585 gal. of sludge amounting to 234.77 tons of dry solids were placed, and in the latter 913,140 gal. with 406.01 tons of dry solids.

The total cost of operation and maintenance was $13,834 or $9.56 per million gallons, based on a total of 1,219.9 million gallons of sewage passed through the plant. Based on a population of 38,300, the per capita cost was $0.303.

Progress of Miami Flood Prevention Project.—According to the recently issued third annual report of the directors of the Miami Conservancy District, the district has 1,725 persons on its pay roll. Sluicing will be the main work for the next twelve months on the five dams under construction.

Bank Protection and Restoration: a Problem in Sedimentation*

By W. C. CURD.

Synopsis.—The protection and restoration of a sliding bank along the Mississippi River at Natchez, Miss., upon which are located the tracks of the Natchez & Southern Railway, is described and illustrated in this paper. It deals with the protection of a railway track on a hill 150 ft. above low water. The hill is composed largely of sand and was subject to constant slides during low water, but of greatest extent during floods in the Mississippi River. These slides had so narrowed the space intervening between the tracks and the brow of hill at the time the work was begun that the safety of the railway company's traffic was in jeopardy and some means for relief had to be found. Economy was the keynote of the design, and how well this was worked out is shown by a comparison between the estimated and actual costs.

The underlying principle of the project was to produce sedimentation during floods. This was accomplished by the construction of a mud-cell dike. After the required amount of sediment had been secured, the exposed banks were permanently protected with concrete slab paving.

The completion of the work required six years, due principally to the many delays and interruptions by high water. However, Nature worked exceptionally well in the execution of the plan, which accounts for the few losses suffered.

Geological, topographical, and flood conditions at Natchez, Miss., as well as the progressive stages in the design, are described in detail. No mathematical formulas or theoretical discussions enter the paper, its chief value being a description of a practical application of sedimentation to the replacement of a river bank which had been carried away by erosion and slides.

Introduction.—The property and tracks of the Natchez & Southern Railway Co., at Natchez, Miss., are located for 2½ miles along the left bank of the Mississippi River. A succession of reverse bends above and below the city indicates the century-old changes which are taking place in the river. The Natchez bank rises precipitously to an elevation from 125 to 150 ft. above low water and being on the concave side of a sharp bend, receives the force of the current for several miles. A considerable amount of revetment has been placed by the Mississippi River Commission along the city front in past years, but it did not extend sufficiently far down stream to prevent erosion along the Natchez & Southern company's property. However, this latter part of the bank does not receive the full effect of the current, since the channel crosses some distance above.

In 1890, when the railroad was constructed, the intervening space between the brow of the hill and the tracks was of adequate width, but protection against future loss by erosion was evidently deemed advisable, since a single row of piles, spaced from 5 to 6 ft. apart, was driven at that time along the water's edge where erosion was in progress. This work was of little benefit, and as the years went by other ineffectual forms of protection were tried with a continued loss of bank. Up to 1912, more than $50,000 had been expended in this manner without satisfactory results.

Following the severe flood of 1912, an examination of the location was made and so much of the bank was found to be lost that it was considered imperative to take steps for relief. Surveys for a new location back in the hills were made, but the estimated cost of a new line was in excess of $150,000. It was deemed advisable, therefore, to make another effort to preserve the river-front location, which could be done, it was thought, at considerably less expense than that required for a new line.

The writer, then drainage engineer for the Missouri Pacific System, and in charge of river-protection work, made an investigation of the conditions and designed an improvement, the completion of which was to extend over a period of from 5 to 6 years, at an estimated cost not to exceed $50,000. The design was subsequently approved and all work in connection therewith completed in the early part of 1918, at a total expense of $38,741. As the results of the work have been satisfactory and some novel features were used, a description thereof may be of interest to the engineering profession.

Character of River Bank.—The geologic formation of the Natchez hills consists of well-defined strata of clay, sand, and a deposit locally known as conglomerate or iron stone. The clay forms the surface covering, is very absorptive, and is 10 ft. or more in depth. The sand is clean and coarse, and lies between the clay and the conglomerate. The conglomerate outcrops slightly above low water in this location. It is dark brown in color and appears to have been deposited in a molten state. It is very hard and brittle, and where it is of any thickness satisfactorily resists erosion. Investigation showed that it lies in several layers, each separated by a light colored clay also of a quality not easily eroded.

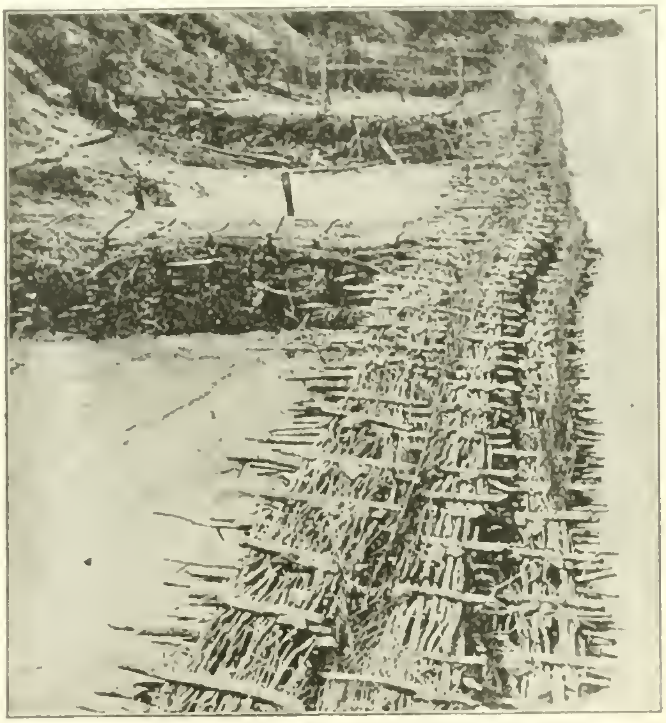


Fig. 1—Construction Details of Mud-Cell Dike.

The sand stratum being exposed along its vertical face was continually being ground away by the action of the elements. The clay was thus undermined and, when saturated by rainfall, would break off in large pieces and slide to the foot of the bank, carrying with it large quantities of the surrounding material. Very frequently after the slides occurred the fallen materials would take a natural slope at the foot of the hill, which for a time prevented further sliding or breaking away at the top. However, the lapping of waves, created by passing boats, soon carried away the toe, and the slides were repeated. During high stages of the river, at a gauge of about 35 ft., direct currents would always set in and cause a rapid loss of bank.

Design of Mud-Cell Dike.—The previous loss of much bank made it apparent that the correction of the difficulty lay, not only in preventing further erosion, but in a restoration of the foot of the bank so that a toe might be formed and a slope worked back to the brow of the hill. Material was scarce, as the few cuts along the track would not yield enough excavation to form the toe, and the expense of having such material loaded, hauled, unloaded, and placed in the right locations along the river-front was excessive.

Mississippi flood waters are always charged with sediment, and when the current is sufficiently retarded extensive deposits of silt can be secured. This fact, therefore, offered an economical solution of the problem of restoring the foot of the slope by taking advantage of natural conditions and producing sedimentation.

With the local conditions to be met, and having in mind his previous experience with various types of control works for producing scour and deposits, the writer decided to adopt mud-cell construction as affording about the cheapest means for getting results. The conglomerate offered a foundation secure against scour and one on which a deposit of required width and height could safely be carried. The problem then was to gather sediment from the river, deposit it to as great a height as possible, and hold it in position against erosion, so that future slides from the top of the hill would find a permanent lodging place and a stable slope be built up by casting over the side of the hill such material as would become available from time to time.

---

*Slightly condensed from a paper prepared for the Transactions of the American Society of Civil Engineers.

The design required that the improvement be carried out in two parts. First, to produce sedimentation, and, second, to protect permanently the slopes after sedimentation had progressed sufficiently. The first part called for the construction of a mud-cell dike with a pile dike at its head as a protection against direct currents, and the second, the construction of a low concrete toe or retaining wall with reinforced concrete slab paving on the slopes above.

In the fall of 1912, the mud cell dike was constructed. It was 1,100 ft long, 23 ft high, and from 75 to 100 ft. from the foot of the hill. The distance from the foot of the hill was regulated by the width required to give a 2 to 1 slope from low water to the top of the hill. The height of 23 ft. put the top of the dike at the 37 ft. level, Natchez gauge, which was considered to be the maximum elevation to which sedimentation could be forced.

The mud cells (Fig. 1) were made from live brush and poles which were cut and towed from an island several miles up stream from the work. A 12-in. foundation mattress, 30 ft. wide, was first laid directly on the conglomerate. This was formed by laying the brush in bundles, or fascines, which were wrapped at 4-ft. intervals with single lashings of No. 9 galvanized wire. Anchor lines of ½-in. galvanized strand, spaced 50 ft apart and woven into the mattress, were run back to deadmen at the foot of the hill. A tier of cells, 5 by 5 ft. was built on the foundation mattress by placing single rows of brush and poles at right angles to each other, very much after the fashion of a log cabin. At a height of 5 ft. the cells were floored over with a layer of brush and a second tier of cells was started 5 ft. back from the river face of the dike. Five tiers of cells were placed in this manner, forming a completed dike 28 ft., or five cells, wide at the bottom and 5 ft., or one cell, wide at the top, and a settled height of 23 ft. All cell walls were bound with wire and cable to the foundation course, as well as to deadmen at the foot of the hill. To prevent the cells from floating when submerged, they were ballasted with loose conglomerate picked up along the river-front. A connection with the hill at the lower end of the dike was made by joining the latter to an old abandoned transfer barge which had been sunk in line during high water just previous to the commencement of the dike.

Six lateral mud-cell dikes, or baffles, 15 ft. wide by 100 ft. long, were connected into the main dike and run up the hill to Gauge 40 to prevent parallel currents and eddies in the enclosed area where sedimentation was being sought.

Through various delays in getting materials and proper pile-driving equipment, the pile dike for the head protection could not be finished with the mud cells, and an unexpected flood came on. An emergency dike was started as soon as there was a sufficient depth of water to get a marine driver on the job, but a satisfactory closure could not be made owing to difficulty in handling the driver in the heavy current. The emergency dike was breached, which resulted in the tearing loose of three uncompleted upper tiers of the main dike for a length of 100 ft. These tiers were floated inshore and, after the flood had receded, were again used by cutting the binding wires and cables and relaying them in the original position.

During the low-water period of 1913 the permanent pile dike to protect the mud-cell dike against head-water was completed. This dike extended from a point up stream to an outside lap connection with the mud-cell dike, a distance of 600 ft. The structure ranges from 8 to 12 ft. in height above the natural ground surface, the top being at an elevation of 56 ft. on the Natchez gauge. It is made up in width of 112 lin. ft. with piles in single rows, 216 lin. ft. in double rows, and 272 lin. ft. in three rows, with 3½ by 10-in. white oak sheeting, spaced 2 in. apart, applied to the outer, or river, face of the dike. Cypress piles ranging in length from 32 to 62 ft. were used and 16 to 20-ft. penetrations were obtained through the conglomerate, under hard driving. The piles were spaced 8 ft., center to center, and driven in staggered position so as to gain additional strength against overturning. This necessitated an intricate system of bracing.

The deflection of head-water in succeeding floods was successfully obtained with the pile dike after its completion in the spring of 1914, and sedimentation progressed very satisfactorily within the area enclosed by the mud-cell dike.

The dikes were permitted to stand through the high water of 1914 and 1915 and until the low water of 1916 without additions or changes. When an examination was made in the summer of 1916, it was found that decay had begun to shew among the brush and poles forming the mud cells, and as sedimentation had progressed to an extent that the enclosed area was practically filled and a growth of willows had appeared on the surface, it seemed advisable to proceed at once with the second part of the plan, the permanent protection of the slopes.

Authority for the required expenditure could not be obtained until the working season of 1916 had become well advanced, but the construction of the toe or retaining wall was started in November of that year and was practically complete, together with a short section of the concrete slabs, when another flood caused suspension of the work and nothing further was done until the low-water period of 1917. The high water, however, caused no damage to the work.

Concrete Slope Wall.—In preparation for the permanent slope protection, all the projecting ends of the brush and poles in the mud-cell dike not covered by deposits, were chopped away. The debris was deposited on the slopes for further use and a trench dug along the foot of the mud-cell dike for the toe wall. The bottom of the footing course was placed at about the 10-ft. level, Natchez gauge, which gave a depth below the exposed surface of the conglomerate of from 3 to 5 ft., this depth being ample to afford protection against under-scour in this location. The toe wall was reinforced with galvanized mesh and carried to a gauge height of 14 ft., at which elevation the concrete slabs were connected to it.

When excavating the trench for the toe wall many small springs were encountered, which necessitated shoring and delayed progress. These springs came from under the hill and yielded such a quantity of water that openings had to be left in the toe wall to provide for discharge into the river. The water was collected and delivered to the openings by 6 by 6 in. drain boxes laid on top of the inside projection of the footing course. The drains were surrounded with bank-run gravel to filter the water and prevent loss of the material behind the wall.

The bulk of the sediment recovered by the mud cells was deposited between the dike and the foot of the hill, and did not completely fill the cells. After removing the projecting cells, it was found that some filling would be required to bring the surface of the slope to the elevation at which concrete paving was to be placed. This condition was provided for by casting the slabs in place on supported forms. The slabs were 4 in. thick, 54 in. wide, 14 ft. long, and reinforced with galvanized mesh. They were placed on a 3 to 1 slope, and cast in alternate sections.

On all supported work, the space underneath the forms was filled with debris from the mud cells. This was done to collect sediment during high water. As the first row of slabs was nearing completion, high water came and, as was expected, sufficient sediment was collected to fill solidly the space thus left. The inclined floor of the forms was made up in panels or sections which were removed after the concrete had hardened sufficiently to support itself. Form-work was unnecessary for the upper part of the slope, and the slabs were cast directly on the ground. The amount of paving constructed was 39,744 sq. ft., being 46 ft. wide on the slope, or up to a level of 33 ft., Natchez gauge, and 864 ft. long.

Cost Data.—A subdivision of the total cost of $38,741 between the three classes of work performed is as follows:

Mud-cell dike	$ 9,292
Permanent pile dike	10,604
Concrete paving and wall	18,845
Total	$38,741

Cross-sections of the amount of deposits obtained through the use of the mud-cell dike were taken, but the records have been lost or cannot be located at this time. However, it is the writer's recollection that approximately 56,000 cu. yd. of material were recovered. On that basis the unit cost of restoring the foot of the bank was 16.6 cts. per cu. yd., very much less than would have been required in that location by any other method. It must be borne in mind in this connection, that had material from the hills been hauled in, some form of protection against its loss by high water would have been necessary until it had settled and the permanent paving was placed.

The general results of the work have been satisfactory and all that could have been expected. A permanent toe has been furnished on which a proper slope can be founded, and the deficiency in the width of the brow of the hill can be filled out whenever the exigencies of the situation demand it.

The frequent interruptions to construction operations caused by high water were aggravating, at times, and occasioned higher costs on some of the work than was desired, yet when the entire project is viewed as a whole, it would seem that Nature at all times worked hand in hand with the engineers.

All work, with the exception of the permanent pile dike, was executed by the railway company forces under various men, as assigned. Special credit is due J. C. Bauer, Inspector of River Protection, Missouri Pacific System, for the execution of the mud-cell dike. It was through his efforts, while in charge of that part of the work, that the greatest obstacle was overcome. Credit is also due Mr. C. B. Colpitts, now of Coverdale & Colpitts, New York City, for the successful completion of the pile dike. The dike was contracted for, but when about 75 per cent complete, the contractors refused to proceed further, and it was completed by railway company forces working under Mr. Colpitt's direction.

The writer left the employ of the Missouri Pacific System in the spring of 1917 during the interruption of the work on the concrete paving due to high water, and the final stage was carried to completion under the direction of his successor, J. A. Lahmer, M. Am. Soc. C. E., Principal Assistant Engineer, Missouri Pacific System.

The permanency of the completed work depends on the permanency of the head protection. When this fails the bank will go back to the condition found in 1912. The writer many times urged the local officials of the Natchez & Southern Railway Co. to have the city garbage dumped behind the pile dike so that a permanent bank might be formed by the time the life of the dike had been reached, and thus avoid the necessity and expense of rebuilding the structure. It is understood that as yet this part of the program has not been put into effect.

Artificial Glaciers for Irrigating Dry Land

An ingenious method for securing a supply of water for their parched fields during the hot season is practiced by the mountaineers living upon the slopes of the Karakorum, the great chain of mountains as the northwest extremity of the Himalayas, and is thus described by Mr. Dainelli, a member of the Italian Alpine Club, in the Bulletin of that organization:

The inhabitants choose points as high as possible in lateral valleys which furnish but little water supply in the summer to the principal valley which it is desired to irrigate. Such spots are chosen as are shut in with steep banks so as to receive little or no sun. During the hot season these valleys are filled with successive layers of straw saturated with water and if possible with dry pine needles and even charcoal. Before the first snowfall the bed thus prepared is covered with pebbles. When the heavy snowfalls of the season are at an end the top layer of snow is covered with straw and then with earth.—Scientific American.

48-Year-Old Concrete Sewer Pipe.—While new connections were being made to the sewers of Lockport, N. Y., recently, it was discovered that one of the lines uncovered was of concrete pipe. An investigation of the city's record showed that on Oct. 13, 1872, a contract was let to Peter Galbally of Lockport for building 297 ft. of 9-in. and 1,137 ft. of 12-in. concrete pipe sewer in Pine St. between High and La-Grange Sts.

J. H. Freshee, City Engineer of Lockport, made an inspection of the pipe when unearthed, and says it was in first-class condition.—The Concrete Builder.

Useful Information on Water Rights

The U. S. Department of Agriculture has just published Bulletin No. 913 on Water Rights by R. P. Teele, Irrigation Economist. The bulletin is such an excellent one that we reprint it in full, omitting only an introductory paragraph.

It is probable that there is no more complicated subject in the whole field of property rights than water rights, yet the practical working of the system is comparatively simple and easily understood. It is believed that a general understanding of the subject is within the reach of all.

General Characteristics of Water Rights.—Though the irrigation laws of the Western States differ in many respects, they agree in several particulars.

The use of streams and other surface water supplies for irrigation and like purposes is subject to control by the States.

Water may be taken from streams and other sources for irrigation and other beneficial uses, but only in accordance with State laws. This is known as the right of "appropriation."

Actual use of the water is a necessary step in the holding of a right and when the use ceases the right is abandoned or forfeited. That is, no one can acquire a right to water and hold it without actually using the water, either immediately or within a reasonable time thereafter. This is known as the doctrine of "beneficial use."

Among users from the same source, the "first in time is the first in right." When there is not enough water for all, the rights are supplied, to the extent of the supply available, in the order of the dates on which they were acquired. This is known as the doctrine of "priority." Exceptions to this rule exist in a few of the States where, in cases of unusual scarcity, the available water is apportioned among the users either by the State officers or by the courts.

The date of a right is fixed by the time of taking the first step to acquire it, rather than by the time of putting the water to use. This is known as the doctrine of "relation," as the rights relate back to date of beginning.

Some of the Western States recognize also riparian rights. A riparian right is a right to use water from a stream which flows through or borders the land to which the right belongs, arising from the fact that the land borders the stream, not from appropriation or use and "use does not create or disuse destroy" the right. Where riparian rights are recognized, each owner of riparian land has a right to make any reasonable use of the water which will not interfere with a like reasonable use of it by all the others. Hence, the value of a right depends very largely on other rights to the same source.

Even in those States where riparian rights are recognized (California, Nebraska, Oregon, Texas, and Washington), appropriation rights are recognized also, and most of the irrigating is done under appropriation rights. Consequently, the subject of riparian rights will not be discussed further.

How to Acquire Water Rights.—In each of the arid or semi-arid States, except Kansas and Montana, the acquirement of rights to water direct from surface sources is under the control of State officials, and one wishing to get such a right must follow the procedure prescribed by law. The procedure is much the same in all the States and consists in (1) making application to some State official or board on forms supplied by the State, giving full information as to plans for irrigation works and use of water; (2) carrying out of the plans as approved by the State; (3) submitting proof of completion of works and use of water; and (4) granting of certificate or license by the State, defining the right as to quantity of water, use to be made of water, and time during which it may be used.

The official or board to which application should be made in each of the States is shown herewith:

Arizona—State water commissioner, Phoenix.
California—State water commission, San Francisco.
Colorado—State engineer, Denver.
Idaho—State commissioner of reclamation, Boise.
Nebraska—State engineer, Lincoln.
Nevada—State engineer, Carson City.
New Mexico—State engineer, Santa Fe.
North Dakota—State engineer, Bismarck.
Oklahoma—State engineer, Oklahoma City.
Oregon—State engineer, Salem.
South Dakota—State engineer, Pierre.

Texas—State board of water engineers, Austin
Utah—State engineer, Salt Lake City.
Washington—State hydraulic engineer, Olympia.
Wyoming—State engineer, Cheyenne

In Kansas and Montana it is required that one wishing to acquire a water right shall post at the point of diversion, and record with the county clerk a notice showing the intention to take water, the amount to be taken, and the use to be made of it. The proposed work must begin within a reasonable time and must be prosecuted diligently to completion, and the water must be put to a "beneficial use." In Montana, if a court has defined previously existing rights to water from a source from which one proposes to take water, application for a right to divert the water must be presented to the court which defined the existing rights. In each of the two States the law specifies what must be shown in the notice posted, and anyone proposing to obtain a right direct from a stream or other surface source should consult the law of the State in which the land to be irrigated is located. In the States given above, application to the State engineer, or the board named, will bring blanks and full instructions. The point to be kept in mind is that title to water is fully as important as title to land, and it should receive the same careful attention. However, very few will have occasion to acquire rights direct from streams, and the subject need not be discussed at length.

Although few farmers will have occasion to acquire rights direct from streams, many will acquire them by purchasing land served by such rights, and rights to water from canals relate back to the rights from the streams or other sources from which the water is taken, and one can judge of the value of rights from canals only by examining their rights to water from the original source. A right to water from a canal can be no better than the right under which the canal gets its supply.

Evidences of Title to Rights to Water from Streams.[1]—Rights to water direct from streams are represented by the following evidences of title: Filings in the county records; filings in State engineers' offices; certificates from courts, State engineers or boards; and permits from State engineers or boards. The force of these evidences of title as guarantees of the value of the rights represented is discussed in the following paragraphs:

The posting and filing of a notice regarding a proposed diversion of water merely gives notice of intention to take the additional steps necessary to the acquirement of a right, and its only effect is to fix the date of the right at the date of filing, rather than at the date of beginning construction. The filing itself gives no right to water, but it must be followed by the construction of works and the use of water. Construction may or may not have followed the filing of a notice, so that, taken by itself, such a filing is of little value as evidence that the party making the filing has a right to the water claimed. No one should purchase a right based on such filing without additional evidence that the right is valid and that there is sufficient water in the source from which water is claimed to supply not only the right in question but all prior rights.

In Colorado, a person wishing to divert water from a stream must file a map and plans with the State engineer, and if the map and plans are in proper form and set forth clearly what is claimed, they must be approved by the engineer and a copy showing this approval returned to the claimant. These filings, like those in county offices, are merely notices of intention to divert and use water, and the approval of the engineer conveys only the authorization to proceed with the other steps necessary to the acquirement of a right. Thus the approval of the engineer is no proof of the existence of a right. As is the case with filings in the counties, the rights represented by plans approved by the State engineer in Colorado may be good, but the approved plans alone are not conclusive evidence of that fact.

In many of the arid States rights to water are defined by the courts, and when rights have been defined certificates are issued to the holders thereof, stating the volume of water to which each is entitled, the dates of the rights, and the numbers of the rights in the order of their priority. These certificates are proof that the persons holding them had at the time the adjudications were made, rights to the volumes of water set forth in the certificates. They do not, however, show that there is water in the stream to supply these rights. As previously explained, these rights are to be supplied in the order of their dates, and if the stream does not supply water enough for all rights those of late date receive no water. A certificate showing that a court has confirmed a right to a certain amount of water from a given stream is no evidence that the holder can get the given amount of water. The value of the right depends upon the relation between the volume of rights of earlier date and the flow of the stream. A further element of uncertainty is added by the fact that rights are forfeited by nonuse, the period of nonuse which brings about such forfeiture being fixed by law in most of the States. A right certified to by a court and good at the time may have been lost by abandonment or forfeiture, although the certificate is still in the hands of the former holder of the right.

In other arid States rights to water direct from streams are represented by certificates from the State, setting forth the dates, extent, and locations of the rights. Such a certificate is conclusive evidence that the holder had a right to the volume of water named in it for use on the land specified, but like a certificate from the court, it does not carry any guarantee that there is or will be water in the source named to supply the right for any considerable part of the season or that the right has not been lost by nonuse. There may be enough prior rights to water from the same source to use all the water in odinary stages of the supply. As with rights represented by certificates from a court, rights represented by a certificate may be lost by abandonment or may be forfeited, without the surrender of the certificate.

Permits from State engineers to appropriate water have different effects in the various States. An approved application constitutes a permit to take water from the source named in the application if any is available. In several States the engineer has authority to refuse to approve an application if there is no unappropriated water in the source of supply, or if the approval is contrary to the public interests. In Idaho, on the other hand, the engineer is required to approve any application that is in proper form. An approved application to appropriate water in one of the first group of States referred to would be some indication, although not a guarantee, that in the opinion of the engineer there was unappropriated water in the source named in the application.

However, some State engineers take the position that the applicant is presumed to have examined the water supply and makes his investments at his own risk; that, furthermore, neither the engineer nor the applicant can predict with any assurance how much water a given stream will supply in any season, and that for these reasons he is justified in approving applications to some extent in excess of the apparent supply if the applicant wishes to take a chance on getting water. Against this practice there is one serious objection—it robs such permits of all value as evidence of the value of the rights represented. Enterprises based on permits to appropriate water which, in all probability, does not exist, are launched, and stock, bonds, lands, or water rights, or all four, are sold to individuals who assume that a permit from a State official to take a certain volume of water from a certain source is a guarantee that water is there to be taken. In this way the holder of the permit transfers the risk, which he fully understands, to parties who do not understand it.

The purchaser of irrigated land should understand that a permit to appropriate water is not a guarantee on the part of the State issuing it that the quantity of water named in the permit is available. Even if water is available, a permit, in itself, does not constitute a right to the use of water. Building works and taking and using water are necessary to the holding of the right. The permit itself fixes the time within which the works must be begun and completed and the time within which the water must be put to use, and a failure to comply with any of the conditions is fatal to the holding of the right.

The States which require applications for permits to appropriate water provide for issuing certificates that the works described in permits have been built and the water put to use. These certificates or licenses are in the same class as court decrees as evidence of rights. Rights represented by certificates or licenses can be lost by abandonment or nonuse just as any other right, but are not so likely to have been since the laws providing for them are comparatively recent and the time for them to have been abandoned is short.

Certificates or licenses representing rights acquired in accordance with permits issued by States and as the results of adjudications made by State boards or officials and based on surveys made and testimony collected by State officials are the best documentary evidence of the possession of rights which are likely to be supplied by streams in average years, since they are based on proof submitted to a State board or official whose duty it is to protect the public and are usually issued after inspection by those officials; court decrees and certificates rank next; while permits from State boards or officials and copies of filings in county or State offices rank last.

---

[1] The foregoing discussion is taken principally from Irrigation in the United States by R. P. Teele.

The preceding discussion may create the impression that there are no good titles to the use of water, but that is not the case. The point is that documentary evidence alone is not sufficient to establish either the existence of a water right or its value. Documentary evidence must be backed by evidence of the existence of a water supply in excess of the demands of prior rights. This involves the study of records of stream flow and of existing use. If a stream supplied continuously a given quantity of water, and each holder of a right continuously used all the water to which he is entitled, the determination of the value of a right would be the simple matter of adding the amounts of all the prior rights and comparing the sum with the total supply of water. But neither the total supply nor the demand made on that supply is uniform. The flow of any stream varies from hour to hour, from day to day, and from season to season, while the demand made by any one user may vary in the same way, so that the probability of receiving water under any right when there is not enough water for all rights is extremely hard to determine. On the same stream there will be early rights whose holders can get water whenever they need it, rights whose holders usually get water as they need it, and other rights whose holders get water only in flood season with all degrees between these extremes.

In States having water commissioners, these officials keep records of the dates when each ditch received water and how much it received. These records, covering a series of years, will disclose what ditches have good rights and whether there is water in any source beyond the demands of existing rights. Where such records do not exist, it is usually possible to learn from local disinterested persons what ditches receive a good supply, what ditches ordinarily are short of water, and whether, in ordinary seasons, there is more water than is demanded by existing rights. A prospective purchaser of a water right should look carefully into both the documentary and the physical evidence of the value of the right to be purchased, giving, perhaps, more attention to the latter than to the former.

Rights to Underground Waters.[2]—Though most farmers who settle on irrigated land obtain rights through organizations of some kind rather than direct from streams, there is large opportunity for individuals to obtain independent supplies of water from underground sources through wells.

With relation to the nature of rights to their use, underground waters are divided into four classes: (1) Underground streams flowing in known and defined channels; (2) underground streams flowing in unknown and undefined channels; (3) artesian waters; and (4) percolating waters. While these classes are distinct in law, it is not always easy to tell to which class a particular supply belongs, in fact, water which has long been considered in one class may be found to be in another class, and thus subject to a different law.

Subterranean streams flowing in known and defined channels are subject to the same laws as surface streams—that is, in most States, to appropriation rights—and one may not take water from such a stream by means of wells or other means if it interferes with the rights of prior appropriators. Ownership of the land on which a well is located does not give any right if the water is, in fact, a part of the stream.

But if a well draws water from an underground stream whose channel is unknown and undefined, the ownership of land carries with it the right to take the water. It is clear that the channel of such a stream may become known as a result of investigation, in which case the stream will become subject to the law of appropriation, and the prior users may stop the use by later appropriators.

Artesian water—that which is under pressure within the ground, so that it will rise in the well to or toward the ground surface—is held to belong to all the land overlying the artesian basin, and each owner of such land is permitted to make any reasonable use of the water which will not interfere with a like use by all the other landowners. In this respect rights to artesian waters are similar to riparian rights on streams—they are not fixed and definite, but depend upon the total supply and the total demand by all owners of land overlying an artesian basin. Since the water is the common property of many owners, it is subject to public control, and most of the States have more or less legislation on the subject.

Percolating water—that is, water moving through the soil, but not under pressure and not confined to a known and defined channel—belongs to the overlying land, and the owner of the land may withdraw all he can get for use on his land.

As stated before, in many instances it is difficult to tell in which class the water found under any tract of land falls, but under the law all underground water is presumed to be percolating water until it is proved otherwise. Artesian water is easily recognized, because it rises above the level at which it is found when a well is drilled. In narrow stream valleys there is a strong presumption that the underground water is a part of a stream and that pumping from a well may be considered an appropriation from the stream. But on the plains, and in the intermountain valleys which contain no streams, there is a strong presumption that water which does not rise above the stratum in which it is found is percolating water and belongs to the landowner.

Rights to Water From Canals, Etc.—As has been stated, most farmers get water rights from canal companies or other organizations controlling enterprises which supply water to farmers.

Rights to water from canals differ from rights to water direct from streams in one very important particular—usually priority does not hold among users from the same canal. Their rights are all on the same basis, without reference to the dates when they were acquired. Each farmer is entitled to his share of the supply belonging to the canal. The companies are supposed not to dispose of water in excess of their capacity to supply it, but the relation of the total rights disposed of and the total water supply should be investigated with the same care as the water supply generally. The character of rights to water from canals and the conditions limiting them are fixed by the contracts, by-laws, and regulations of the organizations controlling the canals, and these are discussed below.

The principal agencies supplying water to farmers are cooperative or mutual stock companies, irrigation districts, the United States Reclamation Service, Carey Act companies, and commercial companies.

Cooperative or Mutual Companies.—Cooperative or mutual stock companies serve by far the larger part of the acreage irrigated by enterprises supply water to farmers—62 per cent of this area in 1910, according to the census reports. Water rights in such companies are represented by stock in the companies, and each share of stock entitles its holder to a share of the total supply of water belonging to the company rather than to any fixed quantity. Water is not delivered in proportion to the acreage but in proportion to the stock owned, although there is a tendency for stock to be held in proportion to acreage. The cost of operation and maintenance is raised by assessments on stock, and the laws of many of the States provide that companies may sell the stock of parties who fail to pay assessments levied on their stock. Usually the stock may be rented, and the lessee may draw the water represented by the stock. In this respect, a right represented by stock in a mutual company differs materially from rights in other companies or distiets. In the latter enterprises the water may be used only on particular tracts of land and if it is not used on those tracts the owners are not permitted to draw it or dispose of it in any way.

The plans of enterprises of all the other classes mentioned, except irrigation districts, contemplate that eventually they will become joint stock companies of the type just described, or irrigation districts.

Water Rights in Irrigation Districts.—In irrigation districts the right to water is an incident to ownership of land within the boundaries of a district and goes with the land. Each acre of land in a district is entitled to its share of the water supply of the district, whatever that supply may be. Here the quantity of water which will be received depends entirely upon the relation between the quantity available and the acreage of land in the district. Thus an examination of the water right of the district itself is the only means of forming an idea of the value of the right. Every district has a nominal water supply of a certain quantity for each acre in the district, but as pointed out, this may be only nominal. The actual supply may be much less.

---

[2] This discussion is based on Kinney's "Law of Irrigation and Water Rights," second edition. San Francisco, 1912.

In districts there is no purchase of a water right, as such, but merely the purchase of land. Districts issue bonds to obtain funds for securing a water supply, and taxes are levied to raise funds to pay the bonds and interest and the cost of operation and maintenance. These taxes, if unpaid, become a lien on the land, and the amount of bonds which must be paid off by each acre of land is in effect the price of a water right for that acre although it may not be called that. At present (1920) there is a very strong tendency to reorganize enterprises of other types, particularly United States reclamation projects, into districts.

United States Reclamation Projects. To obtain a right to water in a United States reclamation project it is necessary to acquire land within the limits of the project and make application to the Reclamation Service for water. For each project the Secretary of the Interior fixes the size of farm unit (the acreage for which one person may obtain water), the price of rights per acre, the quantity of water to be delivered per acre, and the annual charges for water. These items vary for the different projects, but full information regarding any of them can be obtained from the United States Reclamation Service, Washington, D. C. Though the Secretary of the Interior fixes for each project the quantity of water which is to be delivered to each acre of land, the water user on these projects, as under the others, is, in fact, entitled to his share of whatever water is available for the project, rather than a fixed quantity.

Originally the United States reclamation projects consisted largely of public lands, and entrymen on these lands took them subject to the water right charges, and title to the land is not received until the charges are paid. Owners of private lands within these projects are required to apply for water and agree to make their land subject to the water-right charges. There is little public land in these projects open to entry, so that the purchase of private land or relinquishments from entrymen on public land subject to the water-right charges is about the only way to acquire rights under such projects. Before making such a purchase, one should find out from the local office of the United States Reclamation Service the exact status of the land in question with reference to payments made and to be made for water rights. Prices of land or relinquishments will be a matter of agreement between the parties.

Water-right charges are to be paid in 20 years, with no interest on deferred payments.

In 1917 and 1919 many of the States in which the United States Reclamation Service is operating amended their irrigation district laws to provide that districts may contract with the United States for a water supply. It is expected that under these laws the land in reclamation projects will be organized into irrigation districts, when the water-right charges will assume the form of a tax lien, as in other districts. If this is done, the acquirement of land within a district will carry with it a right to water.

Carey Act Projects.—The so-called "Carey Act" (act of Aug. 18, 1894) grants public lands to the States containing arid lands on condition that the States provide for their irrigation and settlement. The States enter into contract with construction companies which build the works and sell water rights to settlers, while the States sell the lands. The States sell land only to purchasers of water rights and the companies sell rights only to purchasers of land.

Water rights are usually sold on deferred payments, and the notes given for deferred payments are made liens on the settlers' interest in the lands and each agrees to give a mortgage on the land itself as soon as he gets title.

The contracts usually provide for the delivery of a fixed quantity of water per acre per year, or for the continuous delivery of a stream of a given size for a given acreage, but they provide also that in case of shortage the supply available shall be divided among all users in proportion to the acreage. Here, as in the other types of enterprises discussed, the relation of the water supply of the company to the total acreage in the enterprise is the important consideration and not the quantity of water named in the contracts.

Most Carey Act contracts provide that the projects shall be turned over to stock companies of the type described, when a certain proportion of the rights are sold. Purchasers of rights receive shares of stock in the new companies, so that when the rights are paid for the works belong to the water users.

Commercial Companies.—Commercial Companies have all sorts of plans for disposing of water rights, but their contracts have a general similarity. The laws of many of the States prohibit the sale of rights which merely allow the purchaser to get water upon the additional payment of annual charges. In consequence, almost every plan provides that the purchaser of a water right shall secure an interest in the works and rights belonging to the company. Usually the plan is the same as that followed in Carey Act enterprises—the exchange of the water-right contract for stock in the company when a certain proportion of all the rights in the company is sold. These contracts, like the others, fix the quantity of water to be delivered, the land on which the water is to be used, and the charges which are to be paid annually until the works are turned over to the contract holders. Here, again, water is to be prorated in times of scarcity.

It is seen, therefore, that under practically every type of enterprise, no matter what the nominal quantity of water to be delivered may be, the actual quantity is a share in the available supply, based, in most instances, on the acreage owned, but in mutual companies on the number of shares of stock owned.

In 1919 Montana enacted a law creating an irrigation commission, and providing that any parties wishing to sell water or water rights or to contract to supply water, shall apply to the commission for a permit. If the commission, after investigation, finds that it is likely that there will not be sufficient water, or that the proposed contracts or terms of sale are not fair, it is to refuse permits. Persons thinking of buying irrigated land in Montana should apply to this commission, at Helena, for information as to the water rights and water supply of the parties offering land for sale.

Distribution of Water From Streams.—Water from streams is distributed to canals in accordance with their rights by public officials, usually called water commissioners. Each commissioner has charge of the water within a certain district. He has a list of the rights showing amounts, dates, and locations, and distributes the water accordingly. In most States commissioners control diversions only when called upon by water users. When there is water enough for all each takes it as he pleases. In the more highly developed communities commissioners are on duty most of the time. Interference with the work of a water commissioner, by changing gates set by him, is a misdemeanor in most States.

Distribution of Water From Canals.—The method of distributing water adopted under any canal system has much to do with the value of its rights to farmers, as it has a large influence on the economy with which they can use not only their water supply but also their time. In many instances the regulations under which water is distributed have more practical effect than the terms of contracts under which rights are acquired. Three systems of distributing water from canals are in common use: In continuous flow; in rotation; and on demand.

Contracts or agreements under which rights are purchased usually provide either for the delivery of a stream of a given size continuously throughout the irrigating season or for the delivery of a certain quantity or depth of water on the land per season; and in many instances where contracts call for continuous delivery, water is, in fact, delivered in rotation. In only a few instances is water delivered on demand.

Delivery in continuous flow is the oldest system, but is giving place to rotation. The size of the stream delivered depends on the acreage, a common ratio being 1 cubic foot per second for 80 acres. Under this system the farmer with a few acres gets a very small stream, while the one with a large acreage gets a large stream. This system has several serious disadvantages. Small streams can not be used economically. On light soils a small stream can not be distributed evenly over the fields, and, whatever the type of soil, irrigating with a small stream takes much more time than should be used for that purpose. When a farmer has a large enough acreage to give him a stream of 2 or more cubic feet per second he can use a continuous flow to better advantage, since it is a large enough stream to work with, and he can rotate the water among his own fields.

Under the rotation systems the various farmers under a canal receive water in turn, and in this way each gets a larger stream than if he received a continuous stream, and he can use the water to good advantage and get through with it, leaving him more time for other work. The quantity of water received is regulated by the length of time a stream is used by each farmer, rather than by the size of the stream. This system has the disadvantage that the farmer can not always get water just when he thinks he needs it, but usually rotation schedules are arranged to fit, as nearly as possible, the needs of the crops grown, and the advantages of having large streams and doing the watering quickly more than offset any disadvantage of waiting for turns.

The ideal system is to get water on demand. In such cases a water supply is like a bank account. The farmer has a credit of his season's supply and can draw as he needs it. This system can be adopted only where storage facilities are available for holding the water until it is called for.

Usually the farmer will have no choice as to which system he will work under, except that he may choose where he will settle, and keep this point in mind in making his choice. If a farmer is acquiring land under an established irrigation system local inquiry as to results under the system will be the best means of determining the satisfactory character of a distributing system, as well as the value of the water supply.

Sewage Disposal at a Saskatchewan Penitentiary

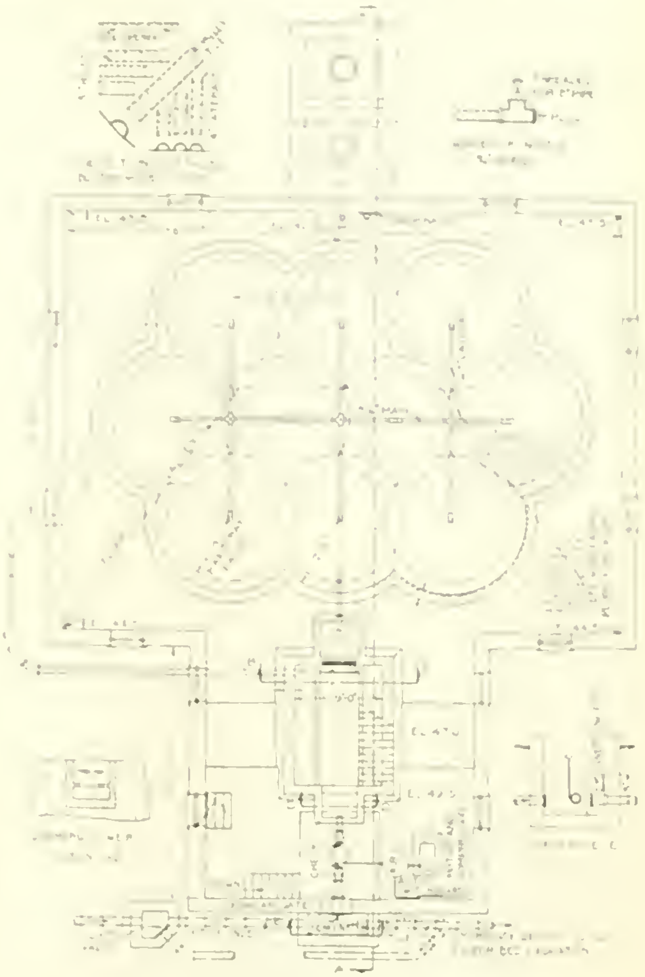
A complete sewage disposal plant entirely housed in, was placed in operation during the latter part of the war to take care of the flow from a penitentiary located on the outskirts of Prince Albert, Saskatchewan, has been successful in its operation even in the extreme cold winters. A description of this plant is contained in an article by R. F. Uniacke, Chief Engineer of Penitentiaries, Department of Justice, Ottawa, in a recent issue of The Canadian Engineer, from which the following notes are taken.

The plant (Figs. 1 and 2) was designed to take care of 255 persons, with a per capita flow of 50 gal. in 18 hours, or a total of 13,000 gal. per day, and consists of a sewage ejector discharging into an Imhoff tank, dosing tank, sprinkling filters, and secondary tank. A screen chamber is provided with two rectangular baskets about 18 in. square and 12 in. deep, which can be lifted from place and cleaned. The sewage ejector discharges 30 gal. of sewage each time, and is operated by an Ingersoll Rand 3½ by 4-in. belt-driven water-cooled air compressor.

The capacity of the Imhoff tank is 12,000 gal. of which 5,000 gal. is sludge storage. The tank is divided longitudinally by partitions so placed as to give a rectangular cross section of 4 by 5 ft. deep, and below this are the steeply inclined baffles for the settled solids to slide down. The dosing chamber has a capacity of 900 gal. between high and low level and contains a Miller dosing siphon. When the overflow reaches a level about 4 in. below the top of the weir, the siphon action begins, emptying the chamber in 8 minutes through the nozzles onto the sprinkling filter bed.

The foundation for the bed and walls of the building was a continuous reinforced concrete mat sloped in three directions and forming two valleys sloping towards the outlet point. Upon this floor was laid channel tile for underdrains. As the cost of stone was prohibitive, brick bats from the brick-making plant at the institution were used for filter media. The brick was broken into pieces ¾ in. to 2½ in. in size and all dust was removed. At the point of outlet a liquid chlorine machine was installed for disinfecting the effluent.

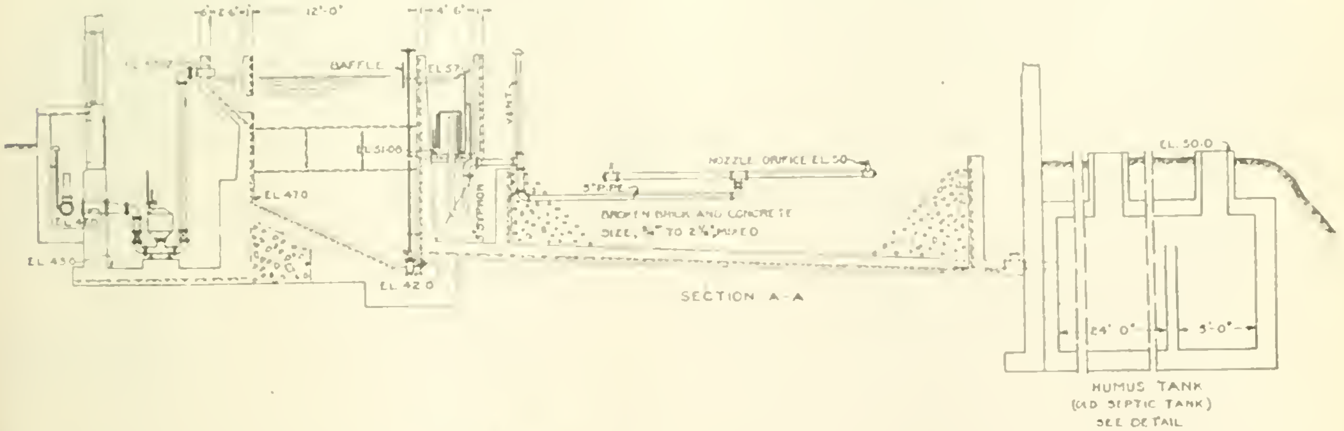
The secondary tank was made by remodeling an existing septic tank built in 1911. A hopper bottom was built in it of broken waste material and surfaced with concrete. The settling chamber is 24 ft. long and 10 ft. wide by 10 ft. deep, and is much larger than necessary, but undoubtedly contributes to the successful operation of this part of the plant.



Plan of Sewage Disposal Plant.

As a protection against freezing the plant was completely housed in with a brick structure, in which are ample lights and ventilators. The building is also steam heated so that the temperature will not fall below 50°, although a continuous low temperature of 30 to 40° below outdoors is not uncommon.

The plant was put in operation during July, 1918, and a clear effluent resulted. The cost to the Department of Justice for materials and labor was $9,700.



Longitudinal Section Through Sewage Disposal Plant.

Note.—All gallons are Imperial gallons.

Self-Cleansing Underground Water Collecting System*

BY GEORGE T. PRINCE.

The speaker was recently called in consultation by the authorities of a western town to overcome a condition which was seriously affecting the public water supply.

This supply is obtained by means of a wooden gallery, which is laid below the bed of the North Platte River, and extends under the river bed for a distance of about 600 ft. from the east bank. It is of square cross-section, 36 by 36 ins. inside dimensions, made up of 2x4 in. planks spaced about ⅝ ins. apart.

The character of the water and material surrounding this collecting box or gallery are of such a chemical nature as to form over and around the gallery an almost impervious curtain which tends to cut off the infiltration of the water supply. Relief has been obtained by periodically excavating the incrusted material which has formed about the gallery, but the relief is only temporary, as the cementing process again occurs within a few weeks.

Another city located to the west on the same river is experiencing similar trouble due to the cementing qualities of the material of the river bed in conjunction with the hard water.

The offering here submitted cannot be dignified by the usual term of a "paper"; it should rather be regarded in the nature of a suggestion to serve as a basis for comment, and it is hoped that it will be of sufficient interest to elicit discussion as to the wisdom of the relief measures that are proposed to be taken and herein described, for it is only by hearty cooperation and profiting by others' experience that we can hope to obtain the maximum good. Our experience of more than 40 years in the design, construction and operation of engineering work teaches us that the self-centered man is a dangerous individual, not only to his own personal interests, but more particularly to the interests of others with which he has to do.

Not only has this particular gallery suffered because of the cementing qualities of the surrounding materials, but we found on examination that considerable quantities of gravel and sand obtained entrance to the interior of the gallery and subsequently to the suction well with which it is connected, thus evidencing improper construction.

An analysis of the water supply indicated serious contamination, and at the time we were called into consultation, there were a number of cases of typhoid in the town. We at once had an emergency chlorinator installed with favorable results. The threatened epidemic died out. Since that time, on our recommendation, the town has purchased a permanent chlorinating equipment.

It is deemed essential to construct another water collecting system, to be located at a point under the river north and above a creek which discharges into the river about a quarter of a mile above the existing gallery, which discharges considerable sewage contamination.

The proposed construction includes a new pumping station located on the east bank of the river about 250 ft. east from the new water collecting system. Near this pumping station a suction well will be constructed from which a 14-in. cast-iron supply main will extend west and connect with the connecting pipe or back-bone of the water-collecting system.

The flow of the river at the location of the collecting system is from north to south. The Pathfinder Dam, constructed by the Federal Government, is located on the river something over 100 miles to the north. During the fall and winter months, this dam stores water, and the stage of the water in the river below the dam is low until the irrigation season opens in the spring. It is therefore proposed to construct this collecting system during time of low water.

The proposed collecting system will consist of a 14-in. cast-iron connecting pipe with tight joints, which will be laid for a distance of about 900 ft. in a north and south direction parallel with and within 50 ft. of the east water line of the river at its low stage. The supply main, which extends west from the suction well located on the east bank of the river, will connect with this connecting pipe, near its south end.

It is proposed to insert in this connecting main at intervals of 100 ft., a cast-iron special wye casting, the branch opening of which will be fitted with a flange, to which an 8-in.-flange valve will be bolted.

The river bed at this particular location resembles a beach, consisting of excellent quality of building sand underlain with washed gravel varying in size from say ½ to 8 in. The elevation of this river bed along the line of the connecting pipe varies from 83 at the south end to 84 at the north end, and the elevation of the flow line of the connecting pipe will vary from 74 at the south end to 75 at the north end.

Extreme low water is assumed to be 80, or 4 ft. below the river bed at the south end of the collecting system. Under usual conditions the elevation of the river water during the non-irrigation season, from say Sept. 15 to Mar. 15, will approximate 82.5.

Examinations that have been made of the sub-soil at the proposed location of the collecting system indicate conditions at this point similar to what exists throughout the entire Platte River basin, namely a very large under-ground flow of water.

Attached to each of the ten 8-in. valves there will be bolted three 12-ft. lengths of 8-in. flange cast-iron pipe, which will be laid in line or angle of the aforementioned wye connections.

Each of these flange pipes will be drilled in three lines of 1-in. holes, 50 holes in each of the pipes, equally spaced and staggered. The extreme end of each branch line will be closed by a blank flange.

Each branch line will be laid for its length of 36 ft. at the same elevation as its connecting wye special in a trench not less than 46 in. in width at the bottom. The trench will be excavated to a depth of at least 12 in. below the pipe and refilled with washed gravel, no particle of which will be less than 2 in. in dimension, the larger particles being placed next to the pipe. On each side of the flange pipe for a width of 18 in. and on top to a depth of 4 ft., washed gravel of like character to that below the pipe will be placed and above this the trench may be filled with excavated material.

Around each 8-in. valve there will be built a concrete manhole, the top of which will be at elevation 90, or about 2 ft. above high water in the river. These manholes will not be subjected to ice-flow as the river is at its low stage during the winter months. These 8-in. valves will be built with rising stems, the floor standards and hand-wheels being erected upon the concrete covers and housed in as a protection against the weather.

In the pump house there will be installed centrifugal pumps, belt-driven by oil engines. The discharge from the pumps will pass south through a 12-in. cast-iron pipe line for a distance of about 1600 ft. at which point it will connect with two existing force mains which are laid to two distributing reservoirs located on high ground east of the town.

The method adopted to guard against the evils incident to the stoppage of infiltration of under-ground water caused by the cementing process and to insure a constant and abundant supply of water, will involve a reverse current of water through a by-pass pipe connecting the discharge and supply mains under a static head of 220 ft. About once a week all of the ten 8-in. valves on the branches of the collecting system will be closed, after which each valve will be opened successively for such length of time as to allow the reverse flow from the reservoir to wash out and remove all matter of a clogging nature that has accumulated around and above the branch pipe.

Assuming the pipe conditions to be such that 3,000 gal. of reverse flow per minute can be delivered to each branch pipe line under a dynamic head of 70 ft., it is evident that each of the 150 holes in the branch pipe line, would have to pass 20 gal. of water per minute requiring a velocity through the holes of 8.16 ft. per sec. If we assume the value of the coefficient of discharge, C, in the formula $V = C\sqrt{2\,GH}$, and assume H to have a value of 70 ft., the formula would indicate a velocity per second of 32.4 ft. Just how much the velocity would be retarded by the gravel filling around the branch pipe lines is indeterminate, but the above figures would indicate a reduction in pressure of 75 per cent, due to the surrounding gravel mass.

It is believed that the resulting velocity of the reverse flow through the surrounding gravel mass would be sufficient to cleanse it thoroughly of all the clogging matter that may have collected therein and restore normal condition.

---

*A paper presented at the Iowa Section of the American Water Works Association.

Sewer Construction with a Dragline Excavator

In building a storm and sanitary sewer in Detroit, a dragline excavator is being used with marked success. The following description is taken from "The Excavating Engineer."

The work is under the direction of Mr. Clarence W. Hubbell, Engineer for the city. Mr. Roy Ackley is Engineer in charge of the job.

Brandon & Hanna, of Detroit, have section No. 2 of this work along Six Mile Road between Mt. Elliott and Conant Avenues. This contract calls for the construction of 7,000 ft. of concrete sewer with an inside diameter of 10 ft. 6 in.

Method of Excavation.—Work was started on May 1st 1920. The trench is being excavated by a Class-14 Bucyrus dragline with a 60 ft. boom and a 2-yd. bucket, mounted on skids and rollers. The excavation is being made on an average of 40 ft. wide on top and 30 ft. deep. The slope carried at the time this article was written is ½ to one, the material standing up fairly well. The contractors however expect soon to increase this slope due to sand conditions that will develop ahead.

The trench is trimmed close to the section required for the forms by the dragline, only three men being required to shape the bottom, and three men to operate the dragline. The material is cast to one side, leaving a berm of about 12 ft., as shown in Fig. 1.

Progress Attained. The dragline has been actually operating but 4½ hours of the 9-hour day, the delay being due to the lack of materials. Twenty-five feet of concrete sewer is being laid per day under these conditions. The dragline has never failed to keep well ahead of the forms, the task being to keep the forms up to the dragline. According to Brandon & Hanna 50 to 60 ft. could easily be laid in 9 hours if materials were available. No delays have been experienced on the dragline.

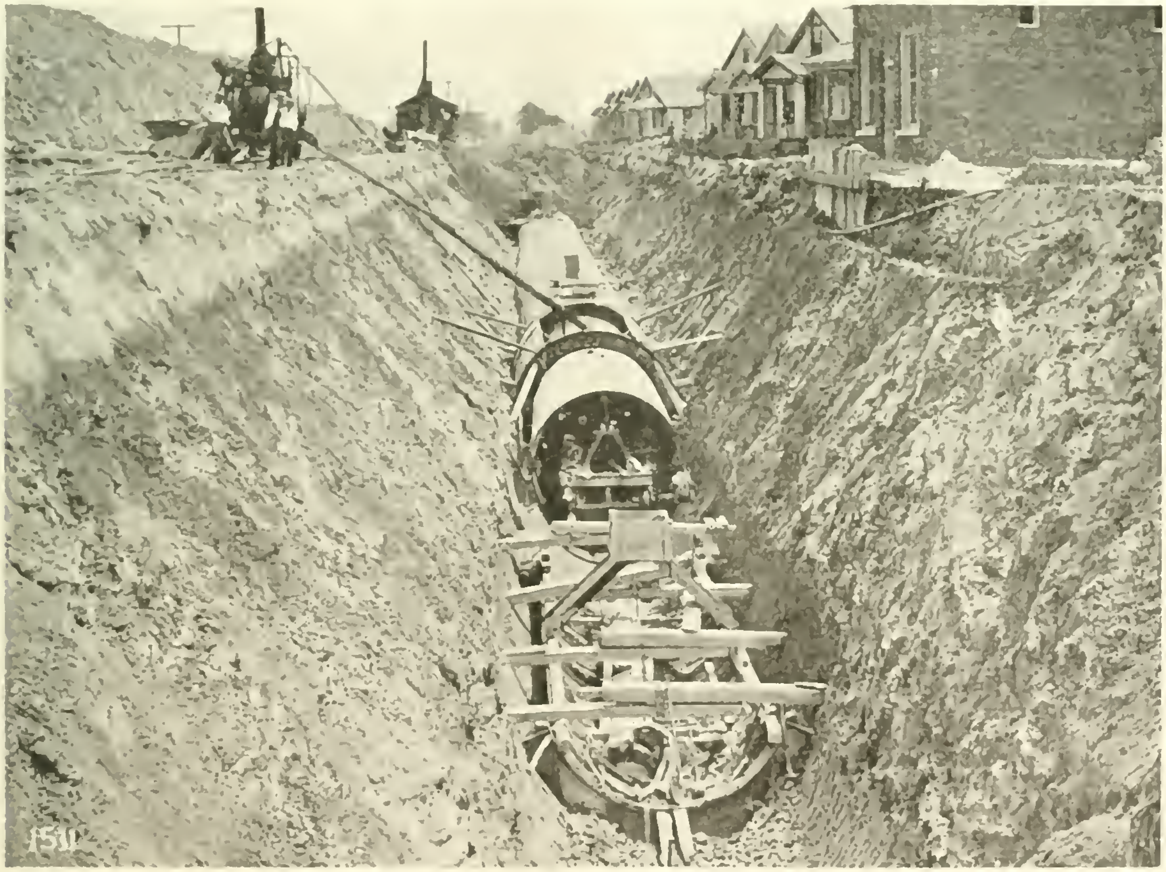


Fig. 2—View of Trench Showing How the Forms Are Set and the Concrete Poured.

Construction of Concrete Sewer.—Blaw-Knox telescopic steel forms (Fig. 2.) being used for the construction of the concrete sewer. The inverted third is pulled ahead and set by the dragline and the arch consisting of the remaining two thirds is carried ahead on travellers and set by ratchet jacks. The concrete is delivered through a chute from a 21 S Knickerbocker steam mixer. The mixer is served by twenty ½-yard Lakewood steel V shaped cars with a 24 in. gauge. They are handled by a Plymouth gasoline locomotive, the haul at present being 2,000 ft. Thirty-five men are being used on the concrete work, including the forms and other work.

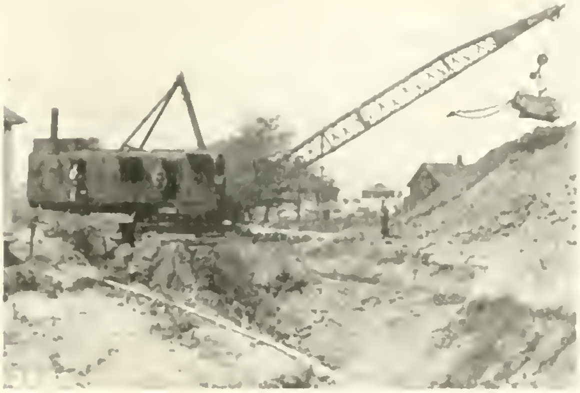


Fig. 1—Dragline Taking Out the Dirt.

Backfilling.—The backfilling is being done with a one-yard clam-shell machine. In order to keep up with the dragline and make work safe, only about half of the spoil is being cast back by this machine.

Edward Gray is Superintendent in charge of the work. Glen Brandon is chief operator and A. Smith, Assistant Operator.

The contractors expect to finish the job in the fall of 1921 but with an open winter they hope to advance this date to the late spring of 1921.

Air Pockets and Vacuum Troubles in Gravity Water Mains

Nearly every water works superintendent has experienced trouble in connection with some phase of air in water mains. Some suggestions and remedies are given in a paper by J. W. Ledoux, Consulting Engineer, Philadelphia, Pa., read before the recent annual convention of the New England Water Works Association, and the following notes are taken therefrom.

Where the discharge pipe is perfectly tight, if a small quantity of air be pumped with the water, it is likely to accumulate on the summits and appreciably reduce the capacity of the pumping main, or what is the same thing—increase the frictional head due to the reduced cross section of the pipe at the summits. The remedy is to prevent the ingress of air at the pumping plant, but even at the best more or less air is entrained with the water, and under reduced pressure at the summits this air may at times accumulate, and then the only remedy is to provide automatic air valves on these summits. However, this difficulty is not common for several reasons. Unless it enters the pumping main in large quantities, it is generally carried along with the water; and if an air obstruction develops, the automatically increased pumping pressure tends to drive it over the summits by attrition. Also, air will escape through apertures too small to show water leaks, and there are usually enough of these to prevent noticeable trouble from pumping discharge mains. This property of air is often the cause of leaks, for in discharging at a high velocity it increases the size of the aperture by washing out fine particles of material that would remain in place if the pipe were full of water.

While the cushioning effect of air in mains often prevents serious water hammer, on the other hand, its sudden escape at a high velocity, as sometimes happens, will produce serious water hammer.

The accumulation of air in summits of gravity mains has frequently resulted in the complete interruption of the supply on large portions of the system, and sometimes this phenomenon is troublesome and difficult of correction.

In one case in the experience of the writer a 14-in. main extended from a distributing reservoir, at elevation 628, across a valley, the elevation of which was 150, to the opposite hill at elevation 550, where there was a considerable amount of population, and very variable topography. Branches from this main extended at right angles in both directions to lower elevations. It was found that no water could be furnished on one of these branches, as was evidenced by the complaints of the consumers. The spigots were opened in houses and the water would not flow even at the ground floor. After many hours of investigation, a pocket of air under pressure was discovered at one of the summits, and as soon as this was released the supply was immediately resumed.

Another case consisted of a 16-in. gravity main extending for 8 miles from an impounding reservoir to 2 standpipes supplying a railroad service. It was found one afternoon that no water would flow into the standpipes, and it was immediately assumed that somebody had closed a valve or that the reservoir was empty, because there had not been experienced any trouble since the line was installed several months previously. An inspection was made; air valves were opened all along the mountain at the various summits; no water flowed and no air came out of the main. It was finally learned that on the day before a valve had been closed near the reservoir to make some slight repair on the line; on inquiry it was found that this valve had been reopened and this was verified. It had been the intention to locate automatic air valves at all the summits. One of these summits was close to the impounding reservoir. Finally this air valve was examined and to the surprise of everyone it was found disconnected and lying in the valve pit. On opening the air valve connection, the air escaped and the water began to flow freely. This particular summit was so close to the reservoir and so small as compared with the others on the line that no one suspected that trouble existed at that point.

One of the most important conditions where serious damage can be caused on a pipe line is in the case of a large wood or steel pipe laid over summits and valleys. If, due to water hammer or defect in the pipe, an actual split or break of the pipe takes place in the valley, permitting a large quantity of water to discharge faster than the water can pass over the summit to keep the pipe full, a partial vacuum occurs, and unless the pipe is designed to resist it, collapse will take place. The only remedy for this danger is to maintain a sufficient number of poppet valves designed to take large quantities of air into the line automatically; some very serious damage has taken place due to the absence or insufficient size of these automatic poppet valves.

In connection with this subject, it may be well to call attention to the best method of filling a gravity piping system that has been emptied for any reason. The writer has heard many experienced water works men advocate filling the pipe line by sections. This is a very bad practice. The best method is to open air valves at all the summits and open the blow-off valves in all the hollows and a sufficient number of hydrants in the town. Then the valve at the impounding reservoir is opened a sufficient amount to fill the line in a predetermined time. As soon as the water appears at the first blow-off and flows full, this is shut, and as soon as it flows full at the second blow-off, that is also shut, and so on until the water appears at the city hydrants, shutting the low ones first and following them up until the high ones are shut; finally, the air valves on the line are closed and the line is in service, and no danger of water hammer has been experienced, and the line is filled in a shorter time than can be done by any other method.

Novel Application of Copper Sulphate to Basin Walls for Control of Algae*

By GEORGE F. BILKISON,

Chief Chemist, Water Department, Kansas City, Mo

The object of this paper is not to introduce a new method for the control of algæ, but rather to show how the Kansas City, Mo., Water Department has, by changing the application of copper sulphate from the water to the basin walls, been able to control this annoying growth in their clear water basins.

Kansas City takes its water supply from the Missouri River at the Quindaro Pumping Station, 10 miles above the city. This station has a basin capacity of 90,000,000 gal. The water is purified by sedimentation aided by coagulation and chlorination. It is then delivered to the Turkey Creek Station, which is the distributing station. We have seven storage basins with a total capacity of 38,000,000 gal., located at different points throughout the city. It is in these basins that the algæ growth causes the most annoyance. The basin becomes very unsightly, due to the fact that Spirogyra predominates and appears in long filaments throughout the basin. It also causes trouble in the meters by stopping up the strainers. At times offensive odors are generated due to the development of anabaena and other blue green algæ.

The method first used to control this growth was to scrub the walls with long-handled wire brushes. This was not successful due to the fact that the algæ were torn loose from the walls and a large amount floated in the water and would become attached to the wall again at the first opportunity.

The next method we tried was taking a known amount of copper sulphate in a sack and by means of a rope attached to it, dragging the sack along the wall on which the algæ were growing. The disadvantages of this method were that the current caused by the sack would carry the copper sulphate solution away from the wall, and the strength of the solution being applied was unknown. This method also required a great deal of time as the sack had to be drawn back and forth over the same wall to kill the algæ.

To overcome the uncertainty of concentration, an experiment was made at the Quindaro Station in which the copper sulphate was applied with coagulent to the water. Copper sulphate being incompatible with aluminum sulphate, the two were dissolved in the same solution and applied to the water as it passed over the weir by means of perforated pipe line. The volume of water passing over the weir was known. We added copper sulphate at this point and in this way were able to calculate the parts per million in the basin. We started with 0.25 parts per million and progressively inceased this to 1.5 parts per million. There was no apparent action on the wall growth until the concentration of the copper sulphate reached one part per million, and at that concentration the algæ at the end of the basin at which the copper sulphate was being applied were killed, but 1.5 parts per million was necessary to clear the far wall. This experiment was followed by an enormous increase in the bacterial count in the basin. The alkalinity of our water at the time of this experiment was 185 parts per million. While chemical analysis were not made on the effluent water from this basin, I feel safe in saying that most of the copper sulphate was lost by reaction with the alkalinity of the water. The following varieties of fish were present in the basins, cat fish, carp, perch drum, shad, and buffalo none of which were killed.

---

*Paper read before the Iowa Section of the American Water Works Association.

Copper sulphate is now used in a known strength solution, and is applied directly to the algae growth on the basin walls. The water elevation in the basin to be treated is brought down below the algae line, which is about 6 ft. below the normal elevation in our basin. This leaves the algae clinging to the wall. A paint spraying pump is attached to an 8 gal. keg which is mounted on wheels and equipped with a handle. A 5 per cent aqueous solution of copper sulphate is made by dissolving 6.5 lb. of copper sulphate crystals in 16 gal. of water and poured into the keg; and while one man operates the pump another man directs the flow of the solution which is delivered in a fine spray. After an hour's time the walls are scrubbed with a wire brush and the basin is again filled to normal elevation.

One gallon of this solution will cover 125 sq. ft. of wall surface and can be applied by two men with a spraying machine in 4 minutes.

We have found that by carrying out this method every two months during the warm weather, we are able to keep our basin walls comparatively free from algae.

Experience with Trenching Machines in Massachusetts

At the annual convention of the New England Waterworks Association a general discussion about the use of trenching machines for excavating waterworks trenches brought out some valuable information. Mr. George W. Batchelder, Water Commissioner of Worcester, opened the discussion with a paper, the substance of which follows:

Machine Trenching in Worcester.—At the annual convention of the New England Water Works Association in 1917, a paper was presented which told the story of the use of the trenching machine up to that time. In order to fully cover the subject up to the present time, it will be necessary to repeat some points in the original paper.

Trench Machine Used.—The machine is a Model O, purchased of the Austin Drainage Excavator Co. in 1913 at a cost of $7,000 less 5 per cent. It is operated by steam, and was selected in preference to the gasoline machine because of the belief that there would be less trouble in securing operators who could handle a steam machine. It has buckets of 18-in., 24-in., 30-in. and 36-in. width, and in each case the cut made is 6 in. wider because the teeth project 3 in. on each side. As stated in the previous paper, trenches can be cut much wider than the buckets by barring down the material on each side of and in advance of the buckets.

The ordinary depth to which the machine cuts for water pipe in Worcesteer is 5 ft.; this, of course, can be made more or less with a range from 0 to 12 ft. Best results are not obtained at the extreme depth because the boom runs so nearly vertical that the buckets spill much of the material before it reaches the conveyor belt. Cuts have been made for a 48-in. pipe line with excellent results.

The machine has developed no weakness, though it has been used in very hard digging. It has done all of the trenching practicable in Worcester streets, and has been rented to municipalities and contractors in Hartford, Conn.; Quincy, Mass.; Dartmouth, Mass., and Auburn, Mass., where it is now in operation. Given a straight run in localities free from obstructions, the machine is at its best and has cut hundreds of feet of trench in a day. For use in the installation of new water or sewer systems in any soil except rock, it will go ahead so fast that the problem is to keep the pipe laid within hailing distance.

Cost Data In Hartford and Auburn.—Examples of its work are shown in these records:

HARTFORD, CONN., 1917.

June 26, New Park Ave., 155 ft. long, 36 in. wide, 5 ft. deep, 5 hrs.
June 27, New Park Ave., 200 ft. long, 36 in. wide, 5 ft. deep, 6 hrs.
July 6, New Park Ave., 220 ft. long, 26 in. wide, 5 ft. deep, 7 hrs.
July 19, New Park Ave., 320 ft. long, 36 in. wide, 5 ft. deep, 8 hrs.
July 24, Quaker Lane, 408 ft. long, 24 in. wide, 5 ft. deep, 8 hrs.

AUBURN, MASS., 1920.

Aug.—
18, Very coarse gravel 41[illegible] ft. long, 24 in. wide, 5[illegible] ft. deep, 8 hrs.
19, Loam, hard pan & grav. 2[illegible] ft. long, 24 in. wide, 6 ft. deep, 5 hrs.
20, Hard pan, clay & sand. 80[illegible] ft. long, 24 in. wide, 6 ft. deep, 6½ hrs.
21, Sand & fine gravel 165 ft. long, 24 in. wide, 6 ft. deep, 3 hrs.
23, Filled land, very rocky 384 ft. long, 24 in. wide, [illegible] ft. deep, 6½ hrs.
24, Coarse gravel & sand. 4[illegible]8 ft. long, 24 in. wide, [illegible] ft. deep, 8 hrs.
25, Very rocky and wet 445 ft. long, 24 in. wide, [illegible] ft. deep, 8½ hrs.
26, Fine grav. & hard pan. 2[illegible] ft. long, 24 in. wide, [illegible] ft. deep, 5½ hrs.
27, Grav., clay & hard pan 4[illegible]2 ft. long, 24 in. wide, [illegible] ft. deep, 8 hrs.
28, Filled land, rocky 180 ft. long, 24 in. wide, [illegible] ft. deep, 1[illegible] hrs.

This total excavation amounts to 34 190 cu. yd. The costs of this work are:

Operator, $88; fireman, $66; freight, $78, coal, $48, oil, etc., $20, repairs and depreciation, ex. labor, $[illegible]. Total $330.

Cost per cu. yd. (excl. rental) . . . . . . [illegible] cts.
Cost per cu. yd., including rental . . . . . . [illegible]
Cost per cu. yd., hand labor (estimated) . . . . . . [illegible] ct.

In addition to the work done in Worcester the machine has brought in a revenue for rentals of $9,011, not including the job now going on at Auburn, Mass. The total cost of replacements and repair parts since the machine was purchased has been $3,864.

The machine shows no unusual signs of wear and is apparently good for many years of service.

Machine Trenching in Springfield.—Following Mr. Batchelder, the following paper was presented by Mr. A. T. Martin, Superintendent of the Springfield waterworks:

Work of trenching in the city of Springfield is done by a Model 24 Parsons Excavator. It is capable of cutting a trench 26 in. wide, and has been used mostly in preparing trenches for laying 12-in. pipe, but has been in service for as high as 24 and even 30 in. pipe. The soil that it has handled has been mostly sandy with little or no rock.

The first work done by the trencher was the digging of a trench for a 16-in. main, and in this work 300 or 500 ft. per day were laid, with a foreman and eight men on the job. A backfiller was also used.

Excavating Over Old Water Main.—Another work the trencher accomplished was the removal of 2,700 ft. of an abandoned water main. As this was not in use and as pipe was at a premium we decided to take it up. Wages of shovelers at this time were 67 ct. per hour, and the economy of using the trencher for this purpose can easily be seen. Twenty actual working days were consumed in the labor. The trench was excavated to the top of the pipe, then, with men to loosen the side, the pipe was lifted out. Three tons of lead were salvaged on the joints of this pipe line and the actual cost of the pipe, which was in good condition, was therefore, deducting the lead saved, $1 per foot including transportation to its future destination. The trench dug in this instance was from 5½ to 6 ft. wide and 6 ft. deep.

Trenching for 30-In. Main.—In digging the trench and lowering the 30-in. pipe the process was to dig one side and then break the sides on the other. The trench was 6 ft. wide and 8 ft. deep, and the speed of operation was 400 ft. in four days. In accomsiplihing this work, bars were left at intervals to hold the pipe and then finally dug away by hand, so that the pipe lowered itself.

The cost of the trencher, which is operated by gasoline, was $7,800.

It was found that when left alone after working hours and at night the trencher was apt to be tampered with by curious persons or mischievous boys. A watchman would cost $35 per week. A cage is placed entirely around the machine and is made of strong steel wire, much like that used in the cages around the cashier's offices in banks. It has fulfilled the object it was devised for. The cost of this cage is about $400.

The operator of the trencher is paid 80 ct. per hour, and the assistant 70 ct.

Method of Preventing Damage by Cable Borers.—The U. S. Bureau of Entomology has been called upon for aid in combating cable borers, which penerate the lead-sheathed cables of telephone companies in California and elsewhere in the United States. Some seasons the damage is quite serious, moisture penetrating through the holes made by the borer and causing a short circuit in wet weather. Various kinds of suspension rings, lead alloys, and chemical repellants have been tried with little success, but the inroads of the borer have been checked by treating the suspension rings with soft tallow.

Sinking Test Holes for a Water Supply Survey

In a survey of the underground waters in the vicinity of Aberdeen, S. D., to determine its availability as locomotive water supply for the Chicago, Milwaukee & St. Paul R. R., 60 test holes were driven. The following account of the manner and methods employed is contained in a recent issue of Railway Maintenance Engineer, in an article by Fred D. Yeaton, Assistant Engineer, Chicago, Milwaukee & St. Paul R. R.

The holes were from 22 to 28 ft. in depth, the upper 10 ft. being usually dry loam and clay, the remainder being wet sand, gravel and quicksand with thin layers of hard, blue clay. Forty feet a day was a fair average under good conditions. The holes cost approximately 42 ct. per foot. The crew consisted of a foreman, two laborers, recorder and a team and driver.

A 4-in. post hole auger was used until wet caving sand was encountered. Then an 11-ft. section of 3-in. pipe was driven with a sheet piling driver to act as a casing. By adding 4-ft. sections, this casing could be made any length and was generally driven 3 ft. lower than the bottom of the hole.

The next operation was to get the dirt out of the casing. This was done by using a 2-in. earth auger. This was screwed down with a 24-in. Stillson wrench; a man walking around and around. In sand or gravel the auger could be turned down about 1½ ft. at a time; in clay ½ ft. was about the limit without twisting the rings on the auger. The auger was then pulled straight up and the dirt knocked out. In very wet sand or quicksand the 2-in. auger could not be used except to stir up the material. On raising the auger the material would all run out. It was then necessary to use the sand pump. By raising and dropping this, the sand and water were forced in at the bottom and held there by the marble valve. When the pump was full it was pulled out and turned upside down, the material running out at the top.

Where quicksand was encountered, it was found best to keep the casing driven down, in order to shut out this sand as much as possible. When quicksand was encountered quite deep, the 2-in. pipe was driven down to act as an inner casing, and the sand pump worked in this. This was not always satisfactory, as small stones, etc., became wedged between 2-in. and 3-in. pipes and made them hard to drive and pull.

When nearing the bottom, a 1½-ft. section of 1-in. pipe was screwed together, adjusted to the proper depth, and driven. Three or four feet was about the limit of this driving, and after that the material would pack so hard inside the pipe that it would not push up; the pipe acting as a solid rod. The pipe was then pulled out, the short sections unscrewed, and the kind of material found inside noted. This method of obtaining information could be only used on the last 3 or 4 ft., as after pulling the pipe the 1-in. hole would immediately fill in again.

In removing the casing, a block and chain were used. Occasionally the block and tackle were used with the derrick to steady the longer sections of pipe. This was the case, however, only when the pipe was withdrawn from deep holes. The saw horses and planking were used to make a staging to stand on when starting to drive new sections of casing.

When using the team, the augers, a few sections of pipe, wrenches, etc., were loaded and immediately hauled to the new hole. Usually the men also rode. The teamster then returned alone, loaded the remaining equipment, and hauled it to the new hole.

The following is the equipment found necessary for a crew of one foreman and two laborers to sink test holes to the best advantage. The test holes did not exceed 30 ft. in depth. The material encountered was caving sand saturated with water:

1 80-lb. sheet piling driver.
1 16-lb. sledge hammer.
2 18-in. Stillson wrenches.
2 24-in. Stillson wrenches.
2 4-ft. lengths of ½-inch chain.
1 4-ft. Fenn post hole auger
3 2-in. earth augers designed for clay.
1 2-in. spring tong auger for stones.
1 7-ft. 1½-in. marble valve sand pump (made of 1½-in. pipe).
1 25-ft. piece ½-in. rope for sand pump.
1 11-ft. piece 3-in. pipe.
5 4-in. pieces 3-in. pipe.
1 16-ft. piece 2-in. pipe.
1 5-ft. piece 2-in. pipe.
5 2-ft. pieces 2-in. pipe.
2 16-ft. pieces 1-in. pipe.
6 1½-ft. pieces 1-in. pipe.
1 6-in. piece 1-in. pipe.
2 carpenter's saw horses 2 ft. high.
4 6-ft. pieces staging plank.
1 3-leg. derrick 16 in. high (made of 2 by 6).
1 block and tackle.
1 4-ft. piece solid ¾-in. rod

All pipe to be threaded on both sides and couplings to be provided.

If many holes are to be sunk and they are more than 500 ft. apart, a team is necessary to facilitate the moving.

Airplane Costs in Hydro-Electric Work

A plan for the use of airplanes as a carrier of men and material in connection with construction work in the mountains as outlined by Ernest W. Dichman, Chief of Structures and Aerodynamics Branch of the Engineering Division of the U. S. Air Service, in a recent issue of Journal of Electricity, shows that, under the assumptions made, a considerable saving in the cost of hauling may be effected. The following abstract of this article is of interest in its deductions.

The assumption is made that a camp 20 miles distant from the nearest railroad at an increase of elevation of 4,000 ft. is to be established. The haul by road is assumed at 40 miles or twice the air line distance. Under circumstances such as these, a motor truck would make the round trip in two days, while mules would require at least four days for the round trip. For an airplane with a speed of 90 miles per hour, 1 hour would be sufficient time for the round trip with an allowance of ½ hour for loading and unloading. On the assumption of an 8-hour day this means that the airplane is 16 times as fast as motor trucks and 32 times as fast as mules. The total amount of material to be transported is assumed as 15,000 tons. The duration of the job will be approximately two years. The ground at the reservoir site will have to be cleared anyway, so the expense of a landing field at this end need not be charged to the aerial transport. It is also assumed that in the winter, the weather is rainy, and the roads are impassable for three months.

The cost of hauling by motor truck is estimated as follows:

Road construction, 40 miles @ $15,000 per mile..	$600,000	
Road maintenance, 2 years, 40 miles @ $500 per mile per year	40,000	
Total cost of road over two years........		$640,000
Direct operating costs of hauling 15,000 tons over 40 miles @ 50c per ton mile..		300,000
Total cost of hauling, including cost of road		$940,000

Note.—The depreciation and repair of trucks, and salaries for chauffeurs and mechanics are all included in the figure of 50c per ton mile.

The road would of course have no salvage value so that no rebate could be obtained from that source, and therefore the net cost of hauling 15,000 tons of material in two years by motor from the railroad to the construction camp, 20 miles distant by air line and at an increase of elevation of 4,000 ft., entailing a road haul of 40 miles, is $940,000, or $1.57 per ton mile.

Let us now investigate the cost of hauling this material by airplane.

For this service we should use two bi-motored airplanes patterned after the bombing airplanes in use during the recent war, but modified by using a high lift rather than high speed wing section, and possibly slightly increasing the area of the wings so that each machine would be capable of carrying 3,000 lb. of useful load.

The power plant of each machine would consist of two Liberty 12 engines each delivering 400 HP. at 1,700 r.p.m., but ordinarily operated throttled to 310 HP. and 1,600 r.p.m. The average speed under these latter conditions will be 90 miles per hour.

Fuel capacity can be limited to one hour as the round trip can be accomplished in less than half that time. Airplanes will be fueled after each round trip.

Each airplane will make 8 round trips a day. As the air haul is only 20 miles this will allow one ½-hour per trip for loading and unloading.

Each airplane will then be actually in the air less than 4 hours per day so that during one year of 313 days it will have flown 1,252 hours, after which it will be salvaged for 25 per cent of its initial cost. This figure is purposely placed extremely low, as to keep each machine in the air 1,252 hours will require 20 per cent of the original cost expended in replacement parts.

During one year's operation two sets of engines will be used and salvaged. The total running life of each engine will then be 626 hours. The salvage value of each engine will be 50 per cent. During the life of each engine it will be completely overhauled six times and at each overhauling 10 per cent of its original cost will be expended in replacement parts.

A Liberty 12 engine consumes approximately 26 gal. of gasoline per hour when delivering 310 HP. at 1,600 r.p.m., so that two bi-motored airplanes actually in the air four hours each day will consume during a year of 313 days 130,208 gal. of gasoline. Allowing approximately 20,000 gal. per year for taxying, testing spare motors and wastage, the total gasoline consumption will be 150,000 gal. per year.

Oil consumption is less than 1 gal per engine per hour, so that the total oil consumption would be 5,000 gal. per year.

A hangar and machine shop for the care of the airplanes will be erected at the railroad landing field only. This need be nothing more than a board and batten building where the initial cost is low but the salvage value is only 20 per cent of the original cost.

Three pilots will be sufficient to supply the necessary reserve in case of illness or relief in order to operate 10 or even 12 hours per day in case of emergency.

Total amount of material transported: As each airplane carries a load of 3,000 lb. 8 times daily, the total amount of material hauled would be—

2 airplanes, 8 trips each, 3,000 lb. per trip, or 24 tons per day.

Working 313 days per year the yearly haul would be 7,500 tons, and in a 2-year period 15,000 tons of material will have been delivered.

CAPITAL INVESTED AND EXPENSES.

Property Investment:		
Preparation of landing fields	$ 1,000	
Hangar and repair shop (for two airplanes)	12 000	
Machine tool and hangar equipment	8,000	
Office equipment	500	
Gasoline tank equipment	3,000	
Total property investment	$ 24,500	
Transportation Equipment Per Year:		
2 airplanes @ $40 000 each	$ 80,000	
8 engines @ $4,000 each	32 000	
Airplane spares, 20% of airplanes	16,000	
Engine spares, 60% of engines	19 200	
Material	10,000	
Total transportation equipment, per year	$157,200	
Over two-year period		$214,400
Direct Operating Costs Per Year:		
Gasoline, 150,000 gals. @ 30c per gal	$ 45,000	
Oil, 5,000 gals. @ 75c per gal	3,750	
Total annual fuel cost	$ 48,750	
Over two-year period		$ 97,500

ANNUAL SALARIES FOR PERSONNEL.

1 Superintendent of transportation	$ 6,000	
3 Pilots at $5,000 each	15,000	
1 Shop foreman	4 000	
2 Rigging mechanics at $2,400 each	4,800	
2 Rigger's helpers at $1,800 each	3 600	
3 Engine mechanics at $2,400 each	7,200	
4 Mechanic's helpers at $1,800 each	7 200	
2 Machinists at $2 400 each	4,800	
2 Machinist's helpers at $1,800 each	3 600	
1 Clerk and stenographer	1,800	
Total annual pay roll	$ 58,000	
Over two-year period		$116,000

OVERHEAD.

Rent and upkeep of landing field	$ 1,200	
Upkeep of buildings	1,800	
Heat, light and power	1,200	
Insurance on buildings and equipment	600	
Office supplies	600	
Total annual overhead	$ 5,400	
Over two-year period		$ 10,800

Note.—Depreciation considered in determining salvage value.

ANNUAL COST OF OPERATION.

Transportation equipment	$157,200	
Gas and oil	48,750	
Salaries	58 000	
Overhead	5,400	
Reserve for unforeseen expenses	10,000	
Annual operating expense	$279 350	
Over two-year period		$558,700

INITIAL INVESTMENT REQUIRED.

Property investment	$ 24 500
Transportation equipment	157,200
Monthly working capital:	
Fuel and oil (approx.)	4,100
Salaries (approx.)	5,000
Overhead (approx.)	5,000
Total initial investment	$195,800

SALVAGE VALUES

Hangar and machine shop 2[illegible]	$ [illegible]400
Machine, tool and hangar equipment [illegible]	4,000
Office equipment, 60%	200
4 airplanes, 25%	40 [illegible]
16 engines, 50%	32 [illegible]
Total salvage value	$ 78,700

NET COST OF OPERATION OVER TWO YEARS

Property investment	$ 24 500	
Operating expense for two years	558,700	
Total cost of operation for two years	$ 583,200	
Salvage values of buildings and equipment	78,700	
Net cost of operation for two years		$504,[illegible]00

It is therefore seen that the cost of transporting 15,000 tons of material by airplane from railroad to construction camp 20 miles distant by air line is approximately $505,000. This represents a saving of $435,000 over the cost of performing the same task by motor truck, or a saving of $29 per ton in transporting the material from railroad to construction camp. The comparative figures are tabulated below:

Cost of transporting 15,000 tons of material 40 miles by motor	$940,000.00
Cost of transporting 15,000 tons of material 20 miles by air	505,000.00
Saving due to use of aerial transport	$435,000.00
Cost of transporting one ton of material from railroad to camp by motor	$62.70
Cost of transporting one ton of material from railroad to camp by air	33.70
Saving per ton due to use of aerial transport	$29.00

In addition to the saving in cost indicated the airplane has the advantage of being able to operate during those seasons when the roads are impassable, keeping the camp supplied with material and allowing the construction to proceed. Of course there are certain limitations to aerial transport, but only a study of the conditions in each particular case can determine whether or not the airplane can advantageously be used. Unfortunately, so much has been written about the airplane in a spectacular vein that this phase of the subject has in the past overshadowed its more useful purposes. However, the time has come for engineers to realize that the safe and sane development of the airplane is due to make it an important economic factor in our daily life, whose points of superiority may be taken advantage of by anyone having the initiative, energy and courage to do so.

Breaking Ice From Elevated Water Tank With a Rifle

A 44-calibre Winchester rifle was used for breaking ice that had formed on the outside of a new elevated water tank, and on a staging left for use in painting the tank, according to an article by D. C. Winsor in the Quarterly of the National Fire Protection Association. Some 600 rounds of soft nosed bullets were used in shooting away the ice in small pieces. The tank has a capacity of 50,000 gal. and is supported by a 90-ft. steel tower. The tank had been erected during the severe winter weather of 1918 to replace an old one. After water had been turned in, a small piece of wood lodged in the check valve on the supply pipe, so the tank overflowed and a large amount of ice attached to the combined structure was formed. Regarding the effect of this on the structure, Mr. Winsor states: "It is estimated by the tank builders that the extra weight carried by the structure for the time mentioned probably amounted to about 15 per cent, or 62,500 lb. extra dead weight. The extra area exposed to wind pressure probably increased the wind load 25 per cent, hence the factor of safety of tank trestle was about 3.4 for the posts. Some struts and wind braces had even a smaller factor of safety, owing to the unevenness of the distribution of the extra ice load." Although the ice was in position for about a week, it does not appear, Mr. Winsor states, that it did any damage to the tank or tower.

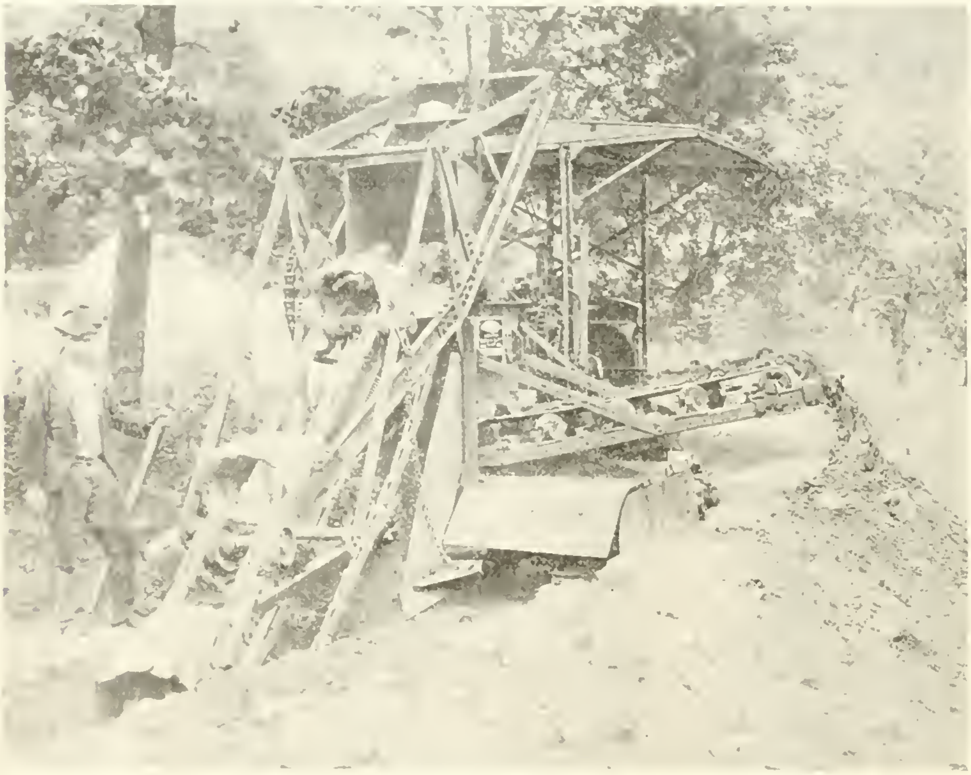
Power Developments in Spain.—Efforts to harness the waterpower in the Pyrenees and transform it into electricity are being intensified, according to a press dispatch. Engineers have surveyed the entire mountain range and have succeeded already in controlling many torrents and making them furnish power. Altogether 200,000 hp. now is furnished and capital amounting to 300,000,000 pesetas has been invested. Engineers employed in the work estimate that in a few years Catalonia will be able to do without coal.

A New All-Multipedal Trenching Machine

This machine is designed to turn practically within its own radius, has full caterpillar traction and is a "one-man" trenching machine.

The full multipedal traction steers through heavy friction clutches (one on each side) its action in this respect being similar to the military "tank." It is of sufficiently light weight to excavate trenches for house connections, sewers, etc. The machine will cross sidewalks, climb over a curb, cross bridges, and travel over any type of pavement, thereby reducing to a minimum the danger of damage claims. It has an unusually high traction speed.

A screw hoist raises and lowers the digging arm automatically, and the endless chain and buckets are of standard type. This screw hoist also acts effectively as a lever to force the buckets to dig, by crowding the bucket line against the face of the ditch or cut.



New All-Multipedal Austin Machine at Work on Trench Excavation.

A cleaning device takes care of the sticky dirt, and scrapes out each bucket as it passes a point at the head of the excavator boom, directly over the conveyor belt. This can be adjusted to deliver the excavated material to either side of the machine. Adjustable screws are provided for taking up slack in the belt.

Strength and weight have not been sacrificed in order to secure a short-based, mobile and very speedy digger.

The illustration shows this new All-Multipedal Austin machine at work on trench excavation.

The gasoline engine is of 4 cyl. 4 cycle type, cooled by an enclosed radiator.

Some of the details which are of interest to sewer, water, gas, electric and oil pipe line contractors and corporations are as follows:

The digging width, with 18-in. buckets, will run from 20 to 28.5 in., and with 24-in. buckets, from 26.5 to 29 in. The standard boom will dig up to 6 ft. in depth, although the machine is equipped for digging 8 ft. deep. The traction accommodates itself to irregular surfaces, as the equipment consists of two oscillating multipedals. Each one of these multipedal tractions is driven independently of the other by a fraction clutch so that in turning in a confined space, one may be stopped while the other is going ahead, turning the machine practically within its own length.

The digging speed naturally depends upon conditions of the soil and the depth of trench.

An important feature of the machine is its easy interchangeability for digging trenches with vertical banks or small ditches with sloping sides.

This machine is made by the Austin Machinery Corp., Railway Exchange Bldg., Chicago, Ill.

Is Municipal Construction Feasible in Winter?*

By W. CLIFFORD CLARK.

Associate Professor of Economics, Queen's University, Kingston, Ont.

In order to find out whether any steps had been taken by Canadian municipalities to decrease the volume of unemployment by a better distribution, over the year, of their contracts for public improvements, and also to obtain the opinion of city engineers on the feasibility of having such works as the construction of sewers and roads carried on in the winter months, a questionnaire was sent in May, 1919, to 50 cities throughout the Dominion. The following questions were asked:

1. Has your city at any time in the past undertaken the construction of public works during the winter months, either as part of a definite policy or on account of particular financial, climatic or labor conditions?
2. If so, did the experiment meet with success, or was the policy found to be impracticable because of greater expense or because of climatic or technical difficulties?
3. If the policy has not been tried in your city, would it, in your opinion, be feasible from the engineering point of view, either generally or for certain classes of public works?
4. Under your climatic conditions, would the financial cost be greater? If so, by how much?
5. What, in your opinion, are the other objections to such a policy, if there are other important objections?

Winter Work Often Done.—The replies to this questionnaire were a revelation. Of the 36 cities which replied to my question, no less than 8 stated that it was their definite policy to carry on the construction of sewers, or the laying out of water mains during the winter months. In several cases the work had been undertaken in the beginning to provide employment during a winter when many were out of work, and the success in the first instance had warranted a continuation of the policy. Thirteen other cities stated that sewers had been constructed at one time or another during the winter months, but merely to relieve the unemployment situation. Others again reported that winter work had been carried on on different occasions in order to complete contracts. Only a small percentage had never undertaken such winter work, either as a deliberate policy or for relief work in the belief that climatic conditions were an insuperable barrier.

The kinds of work pronounced highly or fairly successful when carried on in winter are sewer work in rock, tunnelling, deep excavating, heavy cuts and fills in grading work, concrete construction in large bulk (such as heavy bridge abutments), and construction work in swamp or muskeg sections where sub-surface water prevails.

Complete unanimity throughout the country prevails as to the practicability of rock work and tunnelling. The degree of success, however, depends on the preparation which is made in the fall for continuing the work in the severe weather, and also on the supervision under which the work is conducted. A valuable hint comes from the city engineer of Saskatoon.

---

*Résumé of Replies to Questionnaire, Prepared for Ottawa Convention of American Association of Public Employment Offices, reprinted from The Canadian Engineer.

"If a large sewer were projected in this part of Canada, it would seem that if it were decided to carry out the work in winter, the most economical method would be to have the various shafts sunk before the extreme cold weather, that is, before the frost gets into the ground to a great extent. I believe the work of tunnelling and construction of the sewer could be carried out then in the winter months just as economically as in summer, with the exception that the disposal of the excavated material and also the cost of hauling to the site material to be used would be slightly more. In regard to the latter however, it could be teamed and deposited along the route in the fall of the year.

The estimates of the increase in cost of construction in winter vary all the way from 100 per cent down to zero; indeed in one or two cases winter construction was said to be actually cheaper. In all cases the kind of work and local climatic conditions must obviously be taken into account. For tunnelling there seems a general agreement that the work can be done as economically in winter as in summer; in rock work, the average increase in cost would seem to be below 25 per cent; in ordinary sewer construction, the increase would probably run from 25 to 100 per cent.

Various reasons are given for the increased cost. The frozen top must be broken through, and in some cases the back-filling freezes and has to be blasted. These difficulties offset in part at least by the fact that in excavating the loose earth and rock are held up by the frost instead of having to be shored up. Back-filling with frozen material, however, cannot always be carried out very satisfactorily, and frequently involves higher maintenance cost during the summer. Brick or concrete material must be heated. The men must be kept warm and time is lost in getting to work. Some engineers, on the other hand, contend that "the men work harder in order to keep warm, and practically all agree that it is possible to get men at a lower wage during the winter, though some of those available are not accustomed to using pick and shovel." In this connection some extracts may be quoted from the replies of the city engineers in those cities which have carried on sewer-construction in winter as a definite policy:

"The financial cost is usually not much greater on account of the ease with which labor is secured during the winter months."

"I feel that we get the work done somewhat cheaper."

"It (a particularly difficult piece of sewer construction) was carried on during two severe winters and in my opinion was constructed as cheaply as though it had all been done in the summer."

"The cost of this work was not much greater than the cost of similar work in the summer, as the city is built in general on solid rock, and it is about as easy to take out rock in winter as in summer."

"The experiment, as far as winter construction went, proved a marked success, our cost records showing a saving as against summer." In this case 1.32 miles of the sewers had been constructed in the winter of 1915.

Keeping Force Intact.—When considering labor costs, due account should be taken of the possibility of achieving lower overhead charges by keeping the labor force intact throughout the year. Thus the engineer of Stratford, Ont., writes:

"The policy (of winter construction) has met with success, for although there has been slightly greater expense in the same amount of work, we have been able to keep our labor at work throughout the whole year."

This point also weighed with the City Engineer of Halifax:

"While no definite policy has been laid down, I have always endeavored to keep my foremen employed in the winter so that I should hold them for the summer season and I have always found each succeeding city government ready to carry on some work in the winter in order that unemployment might be as limited as possible."

If the work is let out on contract it will usually be found that the contractors will bid more keenly for winter contracts, partly because labor is usually cheaper, but partly also because of the desire to keep their men together. For this we have the following testimony:

"The contracts (for sewer construction) were awarded in the summer and the contractors chose to continue work during the winter months as being more economical than suspending operations and reorganizing in the spring."

"Ordinarily the financial costs would be no greater, and in former times would probably be reduced as then labor was cheaper in the winter months than in the busier seasons, but during the last two years this has not been the case. However, the overhead charges of a contractor are reduced by extending his working year to 12 months instead of 8 or 9, and he frequently can save enough to meet additional costs in the work chargeable to severe weather."

Dovetailing Different Jobs.—Further, in those cities where construction work is not let out by contract but is done by the city's own labor force there are usually possibilities of dovetailing different operations so as to counteract higher costs. The following extracts will illustrate such possibilities:

"It has been the practice in Galt since 1913 to do construction work on sewers during the winter months. In 1913 the work was done in order to help out the unemployed. Since 1913 one gang has been kept going during the winter in order that we might have men for snow shovelling after each storm, as in addition to cleaning the crossings and walks in front of city property, we also clean some private walks at 1 ct. per square foot for the winter."

"We have (in St. John) in the past undertaken construction work for pipe lines or sewers in the winter with a view to having a small permanent gang on hand through the winter for emergency purposes in case of breaks in mains."

"Further, I might state that this city (Fort William) has for the past two years operated their stone quarry during the winter with the main object of having to keep their road construction organization together throughout the year, also the advantage of sleigh hauling of the material and enabling an early start on the road construction and maintenance program for the year."

An engineer in one of the larger cities gave it as his opinion that the dovetailing of construction work and emergency work would be feasible "for smaller cities and towns where permanent organizations for water works and snow cleaning were not in vogue."

Discussion by Joint Committee.—Through the kindness of Wills McLachlan, the questionnaire to city engineers was brought up for open discussion at a meeting of the Joint Committee of Technical Organizations in Toronto. Their decision which is given below, is the result of a discussion by experts, and should be considered as authoritative:

"With regard to questions 3, 4 and 5, the following conclusions were arrived at: In a certain class of work, viz., underground work such as sewers, etc., it is feasible with a higher cost, owing to the necessity of a higher temperature.

"With regard to excavation the cost is not increased, as work can be carried on as soon as the surface has been broken.

"An instance has been given of building a large camp during the winter. Every kind of work relevant to this nature of construction was completed and the cost was found to be in the neighborhood of 25 per cent excess of similar work done in summer.

"With regard to labor on winter construction, it has been found to be easier to get and cheaper, but about 45 minutes per day is lost in getting to work."

We may conclude, therefore, that if winter construction be undertaken, there will in most cases be an increase in cost of something like 25 per cent. But in those cities where more or less extensive winter operations have been carried on at greater expense, the authorities feel that the extra expenditure is justified by the employment provided in times of distress and by the more equalized distribution of work throughout the year. The attitude of Peterborough (which for the last five or six years has been following the policy of winter construction of sewers) may be taken as typical on this point:

Work Better than "Charity."—"I do not think that the cost is much greater, and labor is employed at a period when there is ordinarily a great deal of distress, and the same men who are employed on this work might be receiving charity from the city funds."

But in addition to the technical and financial problems, a further difficulty should be continued before we leave the subject of winter construction of public works. That is the political difficulty, the difficulty of getting favorable action from the city councils, thanks to changing personnel, elections coming too late in the year, politics, faulty budgetary practices, etc. Previous investigations have shown that city engineers were usually more ready to recommend winter construction than the political officers in charge of the city's administration. These difficulties are, however, primarly matters of organization and administration, and should not prove insuperable. A suggestion which should result in improvement has been made by the engineer of a city in Western Ontario. Because his letter probably sums up the opinions of a good many city engineers in regard to this whole problem, I quote the letter in full:

Earlier Elections Are Desirable.—"Winter construction of municipal works is a question which every year is brought prominently before the City Engineer, and it is regrettable that as cold weather comes on we have to discharge men who have been trained to do certain jobs, knowing that we are not likely to get their services next year. Some work can be done, as the overhauling of plants, repairs to buildings, etc.

"As to the employment of more labor in the winter months, much couud be done in the way of providing materials for work to be done during the coming summer if we only knew what we were going to do.

"It is usually well on to April 1 before the appropriations are made for the works contemplated. The elections are held in January, the so-called organization or naming of committees takes place at the first meeting, pet schemes are aired, but by the time the council evolves a program of constructionu for the current year, three months have passed. During the last three months of the preceding year, as a rule, no new work is initiated, this time being occupied in completing the work instituted in the early summer months."

"If, instead of during the Christmas holidays, the elections were held on or before Nov. 1, the new council could be in a position by the first of January to state what works should be carried out that year.

If all cities and towns did this, the manufacturers of materials required would have a fairly accurate knowledge of these requirements and would manufacture during the winter months most of the materials required by the municipalities during the summer.

"Bridges could be fabricated, water works pipe manufactured and delivered on the ground, and iron appurtenances for sewers made and placed in stock. If the city owns its own stone-crushing plant, stone could be crushed. In this city we haul a lot of stone in winter to the crushing outfit, as otherwise our teams would be standing idle for a great portion of the time.

"The actual construction of municipal works, however, in my opinion is not practicable, outside of the construction of sewers in rock or deep excavating, heavy cut sand fills in grading work, or concrete construction in large bulk as heavy bridge abutments."

Besides municipal public works, there are other undertakings which may be varied somewhat with a view to ironing out seasonal fluctuations in employment. While it is apparently impossible under the existing legislation to vary operations because of periodic fluctuations in industry, there seems no objection to requiring (1) that in so far as is feasible, road-building operations shall be carried on during the late fall, winter and early spring months; and (2) that the supply of machinery, equipment and materials which will be required for each working season shall be anticipated as accurately as possible, and that orders for such supplies shall be allocated with a view to offsetting any depressions in the industries producing the required supplies. If the intent of these two clauses is carried out, the benefits should not be inconsiderable.

Space Occupied by Stored Coal.—The Peabody Coal Co., of Chicago, uses the following figures in estimating storage for coal in yards:

	Cubic feet per ton.
Bituminous.	
Pocahontas lump and egg	35.5
Pocahontas mine-run and nut	36
Pocahontas slack	35
Hocking	41
Screenings	40
Indiana lump	41
Mine-run	36
Smithing	43
Quaker egg and nut	40
Quaker lump	38
Acorn lump	40
New era	38
No. 3 washed nut	42
Wasco lump	40
Anthracite.	
Chestnut	34
Range	35
Small egg	35
Large egg	36
Pea	33

Methods of Building Tile Drains in Quicksand*

By A. R. M'GINNESS,

One of the very important features, if not the most important, in connection with drainage on the Huntley project (Montana), is the construction of drains in quicksand, sand loam, and similar materials saturated with water so that they will remain in their place, preserve their original alignment, and give the service for which they were constructed. The first trouble experienced on the Huntley Project with this class of material was in 1914 in the construction of drain No. 12. This drain is 6,953 ft. long, and practically the entire drain is laid in sand loam, quicksand, or clay material. Practically no gravel was encountered up to station 58+00, and even here it was not of good quality or in large quantities. The slope of the drain where the greater part of the trouble has been experienced is 0.002.

During construction a stiff clay seemed to be the predominating material up to station 50+00; for about 3,000 ft. beyond this point the top soil was a heavy gumbo, exceedingly hard, but underlain with quicksand, so that after the trench was opened by the trenching machine and sheeted the sand flowed continuously into the trench, and it was necessary to remove it with buckets. Thus the banks on each side were undermined and the 6 ft. of gumbo was held in place only by the bracing. These banks usually cracked from 4 to 8 ft. back from the trench and gradually settled down, placing great pressure on the sheeting and making the work very dangerous. At about station 38+00 work was suspended temporarily, as the tile had become clogged with sand and it was necessary to go back about 1,000 ft. and take measures to open it up. In doing the repair work the tile was uncovered at several points, and in every instance was found to have settled vertically varying depths. It was then decided that the original plan of construction was at fault, and accordingly in the repair work or reconstruction substantial ladders replaced those of lighter design and large quantities of gravel were hauled and placed under and around the tile.

The reconstruction was completed and the entire drain finally built, using what was at that time supposed to be good construction methods. Notwithstanding this, the drain has always given a great deal of trouble, and each year has required the expenditure of considerable sums to keep it in successful operation. The major portion of the expenditure has been used in repairing breaks where the tile settlement had occurred in quicksand or other unstable soil. Even the stiffer clays seem to disintegrate and become unstable, thus producing the same conditions that obtained in quicksand.

Drain No. 26, which is 4,156 ft. long with a slope of 0.0025, serves as another illustration of a condition typical of the trouble encountered on drain No. 12 and on drains constructed on several other reclamation and private drainage districts.

This tile drain was constructed during the spring and summer of 1917 and backfilled in the spring of 1918. In the construction of the drain substantial cradles 16 ft. long and made of 4 by 4-in. timbers and 1 by 6-in. crossties 6 in. apart were used for the entire length of the drain. Quantities of large rock and gravel were rammed into the subgrade and the tile covered to a depth of 4 or 5 in. with good gravel. Approximately 16 cu. yd. of gravel to the station were used in the worst places.

The drain gave good results and operated satisfactorily until March or April, 1919, when two or three breaks occurred in the line owing to tile settlement. These were repaired, and the drain was in successful operation until August, at which time about 1,200 ft. of the drain began to settle and the drain became entirely clogged. Some repair work was attempted, but conditions became worse so fast that it was deemed inadvisable to continue.

This settlement seems to occur gradually, and apparently is caused by infiltration of sand from under the tile into the drain, whence it is washed into the trap boxes. The first settlement is possibly very small, and the tile joint is only slightly opened, but as variation from grade becomes more pronounced the larger the joint opening becomes and the more rapidly the settlement proceeds. Instances have been noted where this vertical settlement has been as great as

---

*From the October issue of "Reclamation Record."

6 ft. and equal to 4 or 5 times the diameter of the tile. Trap boxes with bottoms have settled as much as 2 or 3 ft. in some cases.

Mr. A. H Ayers, former project manager, Sosbone Project, reports that similar difficulties have occurred in several instances on that project. In those cases of failure, however, the maximum length of settlement has not exceeded 200 ft.

In the Shoshone Project one such failure occurred five years after construction and another three weeks after construction. In all these cases no special precautions had been taken, such as placing heavy ladders or surrounding the tile with gravel Wherever failure has occurred in quicksand material, some broken tile have been found and settlement has taken place. It is believed that this is true also of practically all failures on the Huntley Project, although in a few cases the tile has never been recovered and in a few the tile removed were all sound. Whether the tile were broken before settlement or after displacement it is hard to determine, though the indications are that the tile were broken during the process of settlement.

Interesting information from the North Platte Project, where a great deal of trouble with tile drains similar to that on the Huntley and Soshone Projects is reported, reveals practically the same class of material with the same conditions obtaining. It has been necessary to construct portions of these drains as many as three times.

The first time some of these drains were built the material was dry; as soon as the ground became wet the tile began to settle out of line and soon the drain became plugged and was put out of commission. The second time these drains were built they were laid on cradles similar to the ones used on the Huntley Project, but no gravel was applied, the cradles simply being laid on a firm base. This, however, proved unsuccessful, coinciding with experience on the Huntley Project.

The third time these drains were replaced piling was driven to refusal at intervals of 3 or 4 ft. In addition to the cradles and their supports, gravel was placed around and especially under the tile. So far there has been no trouble with tile lines thus constructed, provided the piles and supporting posts were placed at close enough intervals.

A very important condition should be noted on the North Platte Project, however, namely, that they have found it impossible to construct drains through some of these places after the water table has risen 2 or 3 ft. above the grade line, except by building open drag-line ditches and then resorting to all manner of vertical and horizontal sheet piling, providing for upward as well as downward pressure on the tile in order to hold them in place. It follows that this kind of work is seldom done except for very short stretches and when driven to it by the utmost necessity. Otherwise these drains are built during the early spring when the water table is down below grade. If such conditions are not obtainable, then open drains constitute the only resort.

On the Huntley project, after the water table has once risen to a point where crops are endangered, it seldom recedes below any desirable grade line, therefore for our difficulties open drains would appear to be the solution, but these are impracticable on this project from both a construction and a maintenance standpoint, and also because the small farm units make open drains very undesirable.

Some very interesting information has been gleaned from a report on drainage in Yakima County, Washington. Mr. T. W. Macartney, drainage engineer, states that very little difficulty has been experienced there with tile drains constructed in quicksand or other mucky material where a sufficient foundation of gravel has been used. The method used is to have the pipe man or tile layer tramp in as much gravel as he can until a firm foundation has been made.

In the cases where extremely soft material was encountered approximately the same system of construction was used as on the Huntley Project; that is, bowlders rammed into place and then surfaced with finer gravel. Cradles were not, however, used to any great extent.

The amount of gravel and bowlders used varied with each specific case; in one instance 20 cu. yd. were used to the 10-ft. station. No case of failure or settlement on this work has yet been noted where sufficient gravel was used.

There have been constructed in Yakima County 78 miles of pipe drains and 74 miles of open drains, reclaiming 85,000 acres of land, at a total cost of $1,030,740, averaging a trifle over $12 per acre.

Briefly summarizing the various construction methods noted, it appears that cradles alone, cradles with gravel under and around the tile, and cradles supported on piling at too great distances have all proven to be unreliable in quicksand, with the exception of work at Yakima, Wash., regarding actual conditions on which we have very little information. Balanced against this we have cradles supported at frequent intervals (3 to 4 ft.) and gravel placed around the tile as the only successful method yet developed positively to prevent the tile settling away from the original alignment.

This method, however, has proven so expensive that it can be used only for short distances and in cases of extreme necessity, and it would probably be impossible to accomplish this class of work where a trenching machine is doing the excavation.

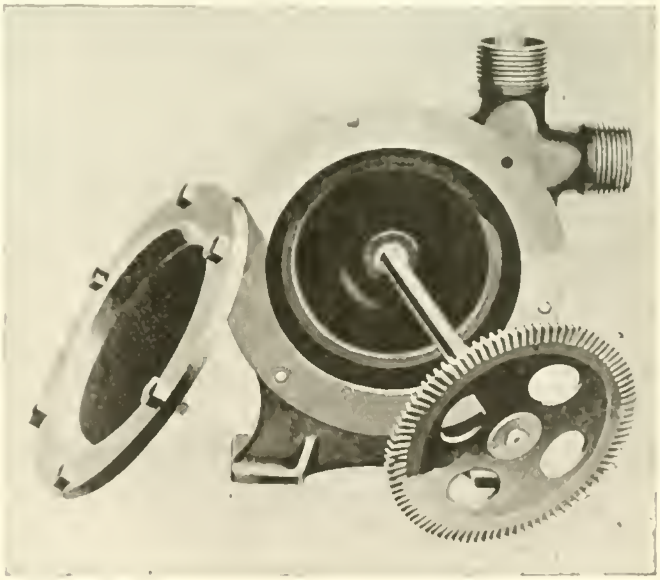
There yet remain several other possibilities, as yet seemingly untried, so far as noted. Among these may be mentioned the possible use of sewer pipe, with a joint calked with a good filter material, these to be laid on substantial ladders and well blinded in gravel. Another method possibly is to use a wood-stave pipe, the lower half of which should be solid while the upper portion could be perforated with holes and these covered with a good filter material which would effectually screen out the minute solid particles, allowing only water to enter the pipe.

The cause of failure of the various tile lines constructed under the conditions described seems to have been due to the saturated material being carried or forced into the tile and thence washed away; and as practically all this material comes from below the tile, it follows that the pressure of the backfill forces the tile down as fast as it is undermined. The problem then resolves itself into devising a method of building tile drains in such a manner that the water alone, with all solid material such as sand, clays, loam, and various other soil ingredients screened out, will have free access to the tile. Effectively to accomplish this result is the problem which must be solved if tile drains are to maintain their adaptability for drainage work under these conditions.

A Pump of Novel Design

A distinctive type of pump containing but one moving part has been designed by the Western Pump Co., Davenport, Iowa.

A circular disc or impeller wheel, having a predetermined number of blades on each side of the outer rim, is attached to the revolving shaft. Pumping action draws the water in at the periphery instead of the center, as is the rule with centrifugal pumps, and discharges at the periphery under pressure. Sizes range up to 60,000 gal. per hour capacity, and it is claimed that the positive action of the plunger type, together with the volume and simplicity of the centrifugal, is obtained in practice.



Pressures are provided for up to 200 lb. to pump any type or kind of liquid. The general design is shown in the accompanying illustration.

A Practical Talk on Some Water Works Matters*

By GEORGE H. FINNERAN.
Supt. of Water Service, Boston, Mass.

It is interesting to consider the changes which have occurred during the present generation in the methods and means of doing the work of a water distribution system.

The automobile has replaced the horse, and while it has speeded up matters it has brought us troubles of its own. The tapping machine, with its special sleeves and valves, and the valve inserting machine, have replaced the old method of shutting down, cutting out with hammer and chisel, and pumping.

Electrical thawing has replaced the slower and more tedious method of injecting hot water into the pipes. The automobile attachment for closing and opening large gates has made their operation easy and quick—a big factor in general maintenance and in main pipe breaks of serious consequence.

Electrically driven pumping units, largely of the centrifugal type, mechanical stokers, and mechanically operated valves have made pumping stations more efficient.

The various jointing compounds have, to a considerable extent, superseded lead, thereby saving bell holes, calking and cost of material. In some parts of the country cement is now being used as a jointing material. Cast iron water pipes are being manufactured and sold with lead joints in the bells ready for calking.

The trenching machine under certain conditions is displacing the pick and shovel. Gasoline and electric power driven pumps are employed where hand worked diaphragm pumps formerly were used. The air compressor, combined with pneumatic tools, has replaced hand rock drilling and hand calking. The differential hoist with its duplex and triplex blocks, is used to advantage in laying main pipe, displacing the rope tackle and the cumbersome winch.

The leak finder, pipe locator, gate finder, aquaphone, detectaphone, geophone, sonoscope, sonograph, sounding rod, pitometer, manograph and Venturi meter, all tend to facilitate the work of stopping leaks, minimizing waste, increasing revenue, etc.

Plunger piston meters have given way to the rotary and oscillating disc types, with more accuracy, especially in small flows. The compound meter with its wide range of service has made it practicable to meter pipes with considerable variation in the rate of flow. Meter testing has been much facilitated by improved apparatus.

The patented flanged couplings, or dry couplings as they are sometimes called, have, to a large extent, displaced the plumber and his solder joint.

Electric and acetylene lights have made night work practical. The electric hand flash light has replaced the antiquated and dangerous candle and the smoky and smelling lantern. The oxy-acetylene torch is proving itself every day to be a money saver by its ability to repair broken castings and metal parts that formerly were considered as beyond repair. The plumbers' torch has replaced the old charcoal furnace with its soldering iron. Gasoline and kerosene lead melting furnaces are used where formerly wood and coke supplied the heat. The large blow torch melts out the cold lead joint where, in the old days, a fire of wood or charcoal was built under the pipe.

Steam, slacked lime, charcoal and the blow torch are now used to remove frost from the ground. Calcium chloride, denatured alcohol, glycerine and kerosene are applied to hydrants as anti-freezing materials. The natural heat of the ground is intelligently utilized to prevent freezing of meters and hydrants.

An improved type of force pump combined with up-to-date methods has made the clearing of stoppages easier and more successful.

The development of the telephone system has facilitated the direction of outside men through means of frequent communication between headquarters and near and distant points.

The development of the emergency gang has resulted in quick service to the public and the control of leaks and breaks with a minimum amount of damage.

The development of the water works associations, with their meetings and journals, interchange of opinions, recital of experiences, collection of data, the work of committees in standardizing specifications, the influence of the organizations in promoting beneficial and desirable legislation, etc., etc., have tended to a very great degree to advance the ways and means of operating a water works system during recent years.

Unsatisfactory Labor Conditions.—The changes indicated in the foregoing have in almost every case proved to be improvements and steps forward along the line of efficiency. They are, however, chiefly, mechanical. In the labor end of the work, I regret to say, there has been no great improvement either in quality or quantity. If it were not for the compensating effect of the many mechanical devices introduced into the work and increased earnestness and energy on the part of the directing forces, I fear we should not have much to report under the head of results.

During the last few years especially, labor as a whole has declined in zeal. It appears to have lost interest in the work. We do not see it displaying the initiative and the sense of duty that was usual in the old days. The newcomer does not have the manner of one intending to stay, to acquire experience and skill as a water works man, and become part and parcel of the system. Rather does he impress one with the idea that his service is to be temporary, a mere filling in while he is getting an easier and higher class job. Possibly this may not be the case in private water companies where the management has a wider scope of selection and full powers to hire and discharge, but in municipal systems I think it will be found so.

There are, of course, good working men to be found in every water works system. They are usually of the old stock and have been in the employ of the cities and towns for some time. They are the stand-bys, the real props, and without them matters would be well-nigh hopeless. They are fast dropping out through infirmity or death and their replacement is a serious problem.

Before leaving this subject of labor I should like to call your attention to the self-assertion of men in recent years as compared with their docility in previous times. While I dare say it is not peculiar to those employed in water yorks, yet I cannot help observing it because it is so comparatively pronounced. Upon the slightest pretext a protest is made to this condition or that grievance. Great attention is paid to the classification of the work. Men are inclined to specialize more than ever. One has to be careful in asking a handy man to lay a few bricks or cut some stone, or repair artificial stone sidewalks; or in asking a carpenter to tack some sheet iron instead of a board to a wall, and so on. You probably will be told by the man that he is not a bricklayer, or a stone-cutter, or a mason, or a sheet metal worker. You may also be told that he "doesn't get the money," and that he "doesn't care to scab."

All this is part of the doctrine of unionism and from certain standpoints is perfectly proper, but it does sometimes slow up the work, especially when one is particularly anxious to do a quick job.

Handling the Men.—Great care and attention is now necessary to keep the men working harmoniously and co-operatively. Temperament is ever present. A superintendent has to be a near psychologist to diagnose the mental oddities found among the men. There are some men who work better alone than with others. There are some men who expect to be told what to do step by step. Others resent such interference. There are individual preferences about working together. There are suspicious men and notional men. There are tricky and sneaky men and there are downright dishonest men. There are stupid men and slow men and lazy men. There are destructive men and dangerous men. There are chronic whiners and men unable to stick for any length of time to any particular kind of work. There used to be drunken men, but I am glad to say that since prohibition we have very few with that failing. When the bootleggers are exterminated we shall not have even that few.

Happily, there are many men who are normal and well-balanced, but it requires much ingenious effort to combine the numerous diverse dispositions into a well-working machine.

As for politics, those of us who are in municipally-owned systems know that it is an ever-present factor operating usually to the detriment of the service. It is so common that we have almost accepted it as a necessary evil. Just so long as the individual is willing to advance his own selfish interests at the expense of the community will municipal work suffer a handicap and fall short of real business efficiency. In Boston, I am glad to say, matters have greatly improved within the last few years and the situation in this respect is quite hopeful.

---

*Abstract of a paper read before the New England Water Works Association, Sept. 1.

There is another disadvantage which the work of a water distribution system endures, and that is its hidden nature. We are underground workers. Immediately upon completion of our work we cover it with 5 or 6 ft. of earth. We cannot display our wares. I have often seen a very fine example of pipe work where the pipe layer was so proud of it that he delayed filling in until somebody in authority could view it. It seems too bad that the public does not see more of our work. It is our lot, however, that we are seldom thought of except upon rare occasions when the faucet is open and the usually never failing gush of one of the most important substances in tho world is missing. The work of the paving, street cleaning, and sanitary branches of the public service is continually before the eye. The public is in contact with it through some of the senses and consequently it is catered to. It is like the handsome daughter of a family, dressed up, kept in the foreground where all may behold her charms, while her plainer and more utilitarian sisters, water and sewerage, are kept in the background, very often furnishing the wherewithal for the embellishment of their fairer sister.

Wages, Salaries and Pensions in Boston.—Laborers receive $4 a day of 8 hours duration. Calkers and repairers, $4.25 to $4.50; pipe layers, $5.00; plumbers, $4.50; chauffeurs, $4.50; machinists, carpenters, blacksmiths, $5.00, pavers, $5.00; meter repairers, $4.50; drillers and assistant machinists, $4.00 to $4.50, and a variety of rates for bricklayers, stone cutters, electricians, storekeepers, yardmen, etc., ranging from $4.00 to $5.60 a day. Foremen, inspectors and clerks are paid salaries ranging from $4.50 a day to $2,300 a year. Meter readers are paid $1,100 to $1,500 a year, and engineers and superintendents $1,100 to $5,000.

All overtime, that is, all time in excess of eight hours, is paid for at the rate of time and one-half, except on legal holidays, when the men who work and who receive day wages are paid double time. Salaried men who work on holidays are allowed time off. All men who work Saturday afterroons are allowed time off and are not paid extra. If a man should work Sunday on a charged job, he is paid double time. The emergency men work seven days a week and receive only straight time except for holidays, when they receive double time. All men receive two weeks' vacation without loss of pay. Also in the event of the death of a father, mother, brother, sister, son or daughter, they are allowed three days without loss of pay to attend to funeral matters. All laborers and mechanics receive a pension of $360 per annum after working 25 years for the city and having reached the age of 60 and having heen pronounced by an examining physician to be unfit for work.

There is another provision which authorizes the city council to retire a laborer or a mechanic upon a pension of $360 per annum after 15 consecutive years of service, with no age qualification but with the requirement of a certificate of disability from an examining physician. Before becoming operative the approval of the mayor has to be secured. Veterans of the Civil War are retired at any age upon half the pay they are receiving at the time of retirement. Disability is necessary in this class as in others. A retiring board, consisting of the city auditor, city treasurer, and the mayor, decides finally on all retirements and they become operative only after the board gives its approval.

Workmen have not fared so well in the water works line as they have in others; I am speaking now for Boston. Ordinary unskilled labor in many cases that I know of has been paid a higher rate of wages on the outside than some of our own skilled men, and as for calkers, I know of several places where contractors have paid them $1 an hour. This has a very disquieting effect on our men and unquestionably has diverted their interest from the work. So far as the remuneration of superintendents goes in these days of high wages and high cost of living, I feel safe in saying that it has not advanced proportionately with that paid to men holding positions of equal responsibility in other lines.

Underpayment of Waterworks Superintendents and Foremen.—Although laborers and mechanics are pensioned, superintendents and foremen are not pensioned in Boston, not in any other city that I have heard of. This, to my mind, is not exactly fair. The average general foreman or superintendent in a municipal waterworks devotes his period of productiveness and high-powered energy to the public service. After passing that period he is unfit to start in any new line of business and successfully compete with younger men. The very nature of his work is such that he does not meet with opportunities for advancement. He is confined to a certain routine and limited to a certain area of action. He cannot go far afield. He must hold himself in readiness to answer the call. It may come when he is in one end of the district or the other, when he is awake or asleep, when he is at home or in church, or possibly in the theater, if he allows himself such a respite from his labors. For my own part, I have acquired the habit of calling up headquarters on the phone whenever I am away from the office or home for any length of time to learn what has occurred in the meantime. I recall one such occasion previously to entering the theater when I was informed of a serious break in a 36 in. main in the downtown section. Had I omitted to make this inquiry I should have sat through a performance for almost three hours blissfully ignorant of that which to a waterworks man is a tremendously important event, viz., a bad break in a large main in a congested section.

This concentration of the mind on water works has a tendency to subordinate all other matters and restricts our field of action. The consequence is that we do not get into the main currents of life, making contacts at various points with diverse interests, as do some men in other lines of work. Hence, opportunities which usually come from those contacts are denied us, and those who are not fitted for the work they are engaged in are unable to find their right places in the world. We continue as mere water works men doing the day's work with no expectation of recognition or reward and only the satisfaction that comes from a faithful performance of one's duty.

The Recovery of "Return Flow" or Irrigation Waste Water*

By A. H. AYERS.

Formerly Project Manager, Shoshone Project, Wyoming.

On any irrigation project the amount of water actually required for plant use constitutes a very small percentage of the amount diverted at the head of the canal system. Losses occur all along the line of delivery, some of which are recoverable, whereas others, such as evaporation, which can be returned only by precipitation, are inevitable. The water thus lost may return naturally through porous subsoils to the stream from which it was diverted; frequently, however, extensive subsurface drainage systems are necessary to prevent the rapid rise of the ground water plane and disastrous waterlogging of cultivated areas. When projects are in the early stages of development and the available water and the capacity of the canal and lateral systems are more than ample to supply the demnd for water, little attention is paid to losses from the system unless seepage of cultivated lands results. When, however, the system is heavily taxed to supply the demand, or the available water supply is restricted by prior rights, the recovery of surface waste and underground seepage becomes increasingly important.

The lands first developed under irrigation in the Western States were largely situated in the valleys closely adjacent to the streams supplying water. These stream bottoms were usually of porous subsoil and water applied in excess of plant needs soon found its way back to the stream and furnished an increased supply to lands farther downstream. In the South Platte Valley in Colorado this rapid percolation back to the stream results often in the return flow furnishing the entire supply for lands lower down the stream.

In more recent developments canals were carried farther and farther away from their source of supply and oftentimes into other drainage areas. The seepage loss from the upper part of the canal found its way into lower canals, but the surface waste from irrigation and the seepage from laterals percolated or discharged direct into channels theretofore dry. On the topography and relative elevation of the lands of such projects depends the measure of their adaptability for utilizing this return flow.

*From the October issue of "Reclamation Record."

On the Shoshone Project about 43,000 acres of the Garland Division and 17,500 acres of the Fannie Division are under ditch. About 14,000 acres of the southern portion of the Garland Division lands drain directly into Shoshone River, and their run-off augments the flow of the river availabe for prior rights below Corbett Diversion Dam. The remainder of the Garland Division drains into Bitter Creek, and its flow at peak seasons is as much as 180 second-feet, about equally divided between surface waste and outflow from drains. The slope of the lands is from 26 to 90 ft. to the mile. Development of a recovery system of surface waste thus far is limited to two major diversions from Bitter Creek, one of 15 second-feet and the other of 50 second-feet capacity, and several minor inlets to laterals. In 1919 with these two diversions a steady recovery of about 35 second-feet was secured into laterals C and W. In the Frannie Division nearly all the lands now under ditch drain into Pole Cat and Sage Creeks. Pole Cat Creek has steep, high quicksand banks and no very large steady return flow as yet. Sage Creek has lower banks and a fall of about 30 ft. to the mile. It is crossed by the Fannie Canal, the Deaver Canal, and Lateral D-56. Wasteways are provided in all these canals; a pickup diversion has been built at the crossing of D-56 and is planned for the Deaver crossing of the creek and for the D-56 crossing of another large coulee which will carry considerable surface waste.

About 24,000 acres of the Garland Division are protected from seepage by a closed drain system containing about 85 miles of tile of 10 to 18 in. diameter, laid on grades approximating 0.005. As these drains have been extended beyond their original proposed length and have tapped an area larger than originally planned, they are at peak season sometimes heavily loaded. To relieve this condition drains of 18-in. diameter on flatter grades have in some instances been tapped into them at manholes and run to emergence from the ground and delivery into surface ditches discharging into laterals. From the most effective of these lines a steady flow of 5 second feet was recovered into Lateral D in 1919, and many similar opportunities exist whereby like steady flows may be secured. The most attractive feature about such recovery is that the flow has no diurnal variation and is heaviest at the time the demand is greatest. Several such relief drains are planned in further development of the drainage system which will at the same time return 10 to 15 second-feet to the lateral system.

The Oregon Basin Project, investigations of which have been conducted by the Reclamation Service the past year, is particularly adapted to utilization of return flow. This project contains about 92,500 acres of irrigable land, of which about 59,500 acres drain into Dry Creek and its branches. Dry Creek acts as the main canal for this area and the various laterals divert from it. At the extreme lower end of the project is an area of about 18,500 acres, the main supply for which is delivered from the Oregon Basin Reservoir through the channel of Dry Creek and a canal diverting from Dry Creek below the major portion of the 59,500 acres of irrigable land draining into that creek. Probably some 45,000 acre-feet of surface waste and percolating underground return will accumulate in Dry Creek during each year after the 59,500 acres are fully developed. Under ordinary operating conditions there would be insufficient return flow early in the irrigation season to supply the demand of the 18,500 acres; at the peak of the return flow there would be a large diurnal variation of flow, and at the end of the irrigation season a return flow in excess of the demand. There is, however, opportunity to construct a regulating reservoir in Dry Creek above the diversion for the 18,500 acres, which will conserve the fall flow for spring use and obviate the difficulty experienced in handling the diurnal variation. Here we have, therefore, almost ideal conditions for maximum conservation of return flow.

Return flow in either dry-creek channels or living streams introduces complications in determining the right to its use, which are now the subject of litigation on the North Platte and Shoshone Projects. Return flow usually develops before there is urgent need of its utilization, and it may be appropriated and beneficial use made of it before such use can be economically secured by the project whose lands provide such flow. Design of a project, therefore should include works to recover, regulate the flow, and reuse in the system the greatest practicable amount of seepage and surface waste that will develop, and appropriations should be made thereof.

The undesirable factor in utilizing return flow is that it removes one of the greatest incentives to economy in the use of water. An unutilized return flow of 100 second-feet resulting from the irrigation of 40,000 acres is a standing reproach against that waste, either on the surface or through the ground. If this return flow is recovered and used on the lower lands of the project, it no longer advertises that project as wasteful of its greatest asset and produces a false impression of economy when the waste may actually be greater than before the recovery system was installed.

Extending Ocean Navigation to the Great Lakes*

By CHARLES WHITING BAKER.

To make the St. Lawrence River navigable so that ocean vessels may reach the Great Lakes, and to develop the water power of the St. Lawrence Rapids, as described by Mr. H. C. Gardner in the last issue of Mechanical Engineering, is without doubt by far the most important engineering enterprise now proposed in the world. Indeed, one may well go further and say that this enterprise promises to yield a larger public benefit in proportion to its cost than any engineering work of the first magnitude ever undertaken.

Perhaps a statement of some of the arguments for the St. Lawrence project, in addition to those made by Mr. Gardner, may make still clearer its value and importance.

The economics of transportation have been revolutionized in the past half century, in that terminal expenses, and not the cost of hauling between terminals, have become the controlling factor. This is well illustrated, indeed, by some of the figures quoted by Mr. Gardner; but it is a fact which few, even among engineers, thoroughly comprehend.

The great advantage of the St. Lawrence Route is that it would eliminate entirely the enormous terminal expenses in the congested terminals on the Atlantic Seaboard. On traffic moved between the Lake cities and foreign ports, a cargo of dressed beef at Chicago, or steel plates at Cleveland, or wheat at Duluth or Fort William, could be loaded directly on an ocean steamer, whose holds need not be opened until the steamer docked at Liverpool or other foreign port. Contrast this with the present cost of transfer between railway car and steamer at an Atlantic port, and the great saving by the St. Lawrence Route begins to be evident.

Another matter not mentioned by Mr. Gardner is that the great fleet of Lake vessels, which are now kept idle by the winter ice blockade for nearly half the year, could go down to the sea every fall and take part in the world's carrying trade during the winter months. Of course, a compromise type of vessel, fitted to navigate both the Lakes and the Ocean, would have to be evolved; but that would come about naturally. The United States is destined to become the great coal supply depot of the world. Vessels adapted to the Lake Superior ore trade could also handle to advantage coal to South America and Europe during the winter months.

But it may be asked, if the St. Lawrence project offers the greatest opportunity for profit in the world, why has it not long ago been undertaken? There are many reasons, but the controlling one is this: the profits from the creation of the St. Lawrence Route will go to the public. It is not an enterprise that can possibly be undertaken by private capital to make money. Had this been possible, it would long ago have been completed. Where public welfare is concerned, however, one finds few willing to give the time and energy required to carry an enterprise from the stage of a mere project to practical success.

Further than this, in order to carry out the St. Lawrence project, at least four Governmental bodies must grant consent or take an active part, viz.: the governments of the United States and of the State of New York, and those of the Dominion of Canada and the Province of Ontario. The various private interests which have reason to oppose the St. Lawrence Route have found it easy, through one or the other of these Governmental organizations, to hinder united action.

The reason why the St. Lawrence project has at last reached a stage where there is promise that it may become a reality, is because an organization has been effected under which fourteen States of the Northwest have united in a league to promote this project, and are doing it officially through their State Governments.

---

*Abstracted from "Mechanical Engineering," October.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. [illegible] Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the **Engineering and Contracting Publishing Company.**

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $1.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., NOVEMBER 17, 1920. Number 20.

The Menace of Government Price Regulation

Growers of cotton and wheat are seriously considerign plans for regulating the prices of their products in a way that would put the buyer at the mercy of the seller. If such price fixing should become established there is no doubt that since the buyers are in the majority, the Government itself would eventually deprive the farmers of the right to fix the prices of their products. There are already several agricultural associations that undoubtedly do "fix" the prices of their products, but it happens that those associations produce only fruits. As fruits are not so necessary as grains, and of much less value in the aggregate, the fruit growing associations have been permitted thus far to do what wheat, corn and cotton growers will never be permitted long to do.

It may be stated as an economic principle that no association of producers will be long allowed to fix the prices of their products, if those products total in value a noteworthy percentage of the gross income of the consuming public. The coal producers are already beginning to recognize this economic principle. Indiana has a law under which the state is regulating the price of coal at the mine. This law has apparently been passed because coal producers had combined to fix prices.

Government price regulation appears to be the only alternative to public ownership where the producer's price is not regulated by competition. Yet our experience with Government rate regulation in the railway field has been far from satisfactory. We doubt whether Government regulation of the prices of basic mineral and agricultural products would be even as satisfactory as the regulation of railway rates.

It is difficult enough to establish a "fair price" for transportation on one railway system. Consider, then, the degree of difficulty that would be involved in fixing "fair prices" for the products of a million farms!

In this connection it may be well to consider for a moment the fact that even where there appears to be no competition to regulate prices, competition of some sort is never entirely absent. The different products of the world are always competing with one another. Each class of thing is bidding against every other class of thing for a portion of the total money in circulation. Textiles are competing with grains, grains with vegetables, vegetables with fruits, fruits with jewels. This sort of competition, which no monopolistic group of producers can prevent, is perhaps more potent in its price regulating efficacy than economists have dreamed it to be.

Why is it that the Raisin Growers' Association is advertising so extensively? Why do railway companies advertise the seeing of America first? Why do motor car associations spend money promoting the building of better roads? The answer is obvious. In this country of bountiful incomes widely distributed there is so much excess of income over what is needed for the true necessities of life that hundreds of classes of services and commodities are competing with one another for "their share of business." Now this competition makes it impracticable for any group of producers to enjoy continued prosperity very long if they try to extort prices that are regarded as exorbitant.

Such necessities as coal, even when sold under an agreement to hold the prices above a normal "fair rate," can not long escape the retaliatory effect of attempted extortion. There are many ways by which an outraged public can "get even" aside from price regulation or severe taxation. To begin with, it is safe to say that half the coal used in heating buildings can be saved by relatively inexpensive expedients. Most of the heat is lost by conduction through window panes, and half this lost heat can be saved by using double windows. By means of "gas-filled windows" (that is, double-paned windows filled between with carbonic acid gas, three-fourths of the heat now lost through windows can be saved. Improved furnaces, heat-insulated flues, and scientific firing are well known but little used means of cutting domestic coal consumption.

As for the use of coal by railways, A. H. Armstrong, chairman of the Electrification Committee of the General Electric Co., estimates that it requires one-third as much coal to haul trains by electric locomotives as by steam locomotives. Add to this the fact that there is available enough waterpower to dispense almost entirely with the use of coal for power purposes in about half the states in the Union, and you will see how slight is the real monopoly that the "coal barons" enjoy

Even a temporary extortion on the part of any association of producers is highly objectionable But in order to escape exorbitant prices for a short period, we should beware of Government price regulation that will result in an economic stagnation over a long period. Let us not forget the 15-year stagnation in the railway field, and its bad effect on almost every class of industry.

In the absence of Government price regulation of iron, coal, wheat, cotton and other basic commodities, what means can the public best adopt to secure protection against even short periods of extortionate prices? Probably the best means is publicity as to costs and profits. Curiously enough many of the very "trusts" that were once the objects of fiercest denunciation, are perhaps the best object lessons now as to the beneficent effects of publicity. The "steel trust," whose gross and net earnings are published at short intervals, is no longer looked upon as a rapacious monster: nor is its policy of "stable prices" denounced. Similarly "the great telephone trust," largely through its policy of publicity, has come to be regarded as "a good monopoly," as in fact it is for when, over a period of many years, an organization has been able steadily to improve and extend its services, coincidently lowering its prices relatively to the income of its customers, and has distributed only 8 per cent annually upon the actual cost of its plant, a critic must be extremely radical who would complain of its monoplistic nature. It is true that the American Telephone and Telegraph Co. is now subject to Government regulation as to rates, but it is equally true that for many years before such regulation its rates were steadily reduced by its own volition, and that during the long period of non-regulation telephone rates were decreased more rapidly than they have been during the short period of Government regulation.

This last remark is also applicable to railway rates in America, namely that they decreased much faster prior to public regulation than subsequent thereto. The following was the average freight rate per ton-mile for the years named:

Year	Cts.
1860.	4.10
1882	1.24
1905..	0.77
1915.	0.73

The era of railway rate regulation began about 1905, and in the succeeding 10 years the net effect was a reduction of only 5 per cent in average freight rates. Contrast this with a 70 per cent reduction in the 22-year period between 1860 and 1882, the era of excessive railway competition; and with 40 per cent reduction in the 23-year period between 1882 and 1905, the era of moderate competition. A thoughtful pondering of such data is not apt to arouse any high degree of enthusiasm for the economic benefits derivable from Government regulation of prices.

Why More Engineers Should Be Members of Public Utility Commissions

Forty-seven states have a total of 167 public service commissioners, of whom 5 are members of one of the four "founder engineering societies" namely, Am. Soc. C. E., Am. Soc. M. E., Am. Inst. M. & M. E., Am. Inst. E. E. In other words, only 3% of all the men whose function it is to pass judgment on public utility appraisals and rates are members of any one of the four great national technical engineering societies.

If only 3% of all the judges of the supreme courts of all the states were lawyers, what would the national and local associations of lawyers do about it? Would they sit supinely year after year, as our four great engineering societies have sat? Would they not be up in arms against the irrationality of having state courts of law, 97% of whose members were untrained in law? But it may be replied, the implied analogy is far-fetched A judge should understand law, but a quasi-judicial body, like a public utility commission, need not have technical knowledge It need only have judicially-minded men of ordinary intelligence For its legal advice it may look to its attorneys; for its technical advice it may look to its engineers; but for justice it must look into its own soul.

Now this argument has a speciousness that serves to silence further query on the part of the average man. But let no man not be silenced by generalizations. Let us look at the process of passing judgment in some given class of things where good judges are knowable by the good results of their decisions. Let us take medical diagnosis for example. If a man is ill, whom does he seek to judge the cause of his illness? A doctor, of course. And if his doctor is in doubt as to his own diagnosis of the case, to whom does he send the patient? A specialist, of course. Now what sort of man is a specialist, and why is a specialist's judgment regarded as more reliable than that of a non-specialist in the field of the given specialty?

A specialist is one who by observation and study relative to a limited class of things has acquired an unusually, exact and extended knowledge of that limited class of things. He therefore notes differences where, to the non-specialist, there is naught but similarity, and coincidentally he perceives similarities where the non-specialist sees only differences. Since good judgment consists in perceiving all the pertinent factors and noting their precise relation and significance, it follows that the best judge in a given class of things is one who knows the most about that class of things.

We are all guided by this generalization in the affairs about which we know the most and we are apt to go mildly away from it only in those matters about which we know little. Thus, lawyers seek specialists in law when they want the best legal judgment; doctors seek specialists in medicine when they want the best medical judgment; engineers seek special consulting engineers when they want the best engineering judgment. But when the public selects its judges of technical matters, it usually selects non-technical men, and this it does largely because it is so wholly ignorant that it fails to realize that the problems these judges are called upon to solve are mainly technical problems.

The ill repute into which expert testimony has fallen is largely attributable to the ignorance of judges; for a specialist can, intentionally or by accident, so becloud the vision of a judge ignorant in that specialist's field that the judge becomes uncertain whether black may not be white. After listening to two opposing specialists, the judge is in a mood to denounce all expert testimony, never once dreaming that an expert judge sitting upon the same case, might see the truth where he himself sees only contradiction.

A modern public utility rate case when well presented to a public utility commission, is a complex of highly technical problems in engineering and business economics. That this is so needs no argument if the reader has himself prepared an appraisal and an analysis of income, expenses, fair-return rates, etc. Even those who are inexperienced in such matters might safely infer the high technicality of public utility rate cases from the fact that there are thousands of articles on appraisal and rate matters in the recent files of engineering magazines. Coincidentally it might be inferred that only the careful readers of such articles are apt to have enough knowledge of the subject to be able to weigh correctly the evidence of experts.

To master the technical language that is needed for an understanding of all the testimony of appraisal and rate experts is itself a big task. Indeed, it is so big a task that we venture to say that a civil service examination of the 162 non-technical members of the state public service commissions would disclose the fact that the great majority of them could not define 60% of the technical terms used by engineering and accounting witnesses.

The editor has read many decisions of public utility commissions in which the very language of the decisions betrayed the ignorance of the meaning of technical terms used in the decision. When a commissioner ventures the use of a technical term it is apparent that he thinks he understands its significance. So he uses only the few technical terms that he believes himself to have mastered. Then what of the many technical terms used by the witnesses, which commissioners fail to use in their decisions?

If it were not for the fact that many commissioners rely upon their own engineers to guide them, their decisions would often be a sorry mess, indeed. But where they do thus rely upon the judgment of their engineers, who is it that is rendering the decision—they or their engineers? Since it is clear that in all such cases their engineers are the real judges, why, we ask, are not the real judges given the title and the position they deserve? It is not mere justice that pleads for such an act. Common sense prescribes the act, for common sense tells us that both the witnesses and the advocates should know whom they are addressing as the judge of their statements. It is nothing short of engineering disgrace that the most technical courts we have in America—our public service commissions—are 97% non-technical as to membership. We do not urge that they should be 100% technical, for there are other than purely technical data presented for their consideration. There should be at least one engineer on every public utility commission. Perhaps one member should be a lawyer, and one a business man of broad experience.

Can Engineering Positions Be Made More Permanent?

One objection often raised to railway employment, particularly for the engineer, is its lack of permanence. It is true that the insecurity of engineering positions with the railroads has not been a serious stumbling block in the recruiting of the technical graduates fresh from school, but it has served to turn many thoroughly seasoned railway engineers into other channels of opportunity. One or two bitter experiences with unemployment after periods of untiring, faithful service are enough to chill the ardor and love of almost any man for his chosen field. This problem is closely related to that of compensation, and the successful solution of the former will do much to reduce the difficulty of the latter. Railway engineers have suffered more than members of other departments because their work is largely related to capital expenditures which are increased or diminished as financial considerations dictate. Except in the case of the line officers of the maintenance of way or the mechanical departments, the work of the engineer is not such as to make him an indispensable cog in the transportation machine. Consequently, his services have been often dispensed with at the first signal for retrenchment. Much of engineering work is of a transitory nature, but there is opportunity for bettering the lot of the engineer by providing for the useful employment of larger proportions of the corps during the slack periods.

One lesson is to be found in the fact that some railroads have been able to pursue a fairly consistent policy with respect to improvements, thereby obtaining many advantages not to accrue in the case of erratic spasmodic programs, under which employment is especially uncertain. Another suggestion is the more complete preparation of engineering plans in advance of actual construction. Too much work has been done with a rush by new corps hired at the eleventh hour. Greater attention to the human element in laying the plans for projects should usually enhance the attractiveness of the work without detracting from its economies. —Editorial in Railway Age.

The Newer Branches of Engineering

Just why it is we do not know, but engineering seems to be getting more popular. Perhaps it is the free advertising which Herbert Hoover has given the profession, or possibly the Federated American Engineering Societies is having some influence. But, anyway, an engineer is no longer considered one who runs an engine, just as a chemist is no longer merely a soda-water clerk.

The latest is Real Estate Engineering, or, as the pioneers in the profession call it, Property Management Engineering. This is the heading of an advertisement occupying the entire last page of the New York Tribune of Oct. 23. The advertisement goes on to say that engineers are scientists who know the facts about materials with which they work and who must not merely guess. They must also have the ability to put their knowledge to practical use. That is just the way the officials of the company running this ad feel about the handling of real estate. Hence the title. They admit that the question as to what Property Management Engineering means has been asked them many times, and we do not wonder.

Julian Street, in his interesting little satire on the modern advertising man, just published under the title "Sunbeams, Inc.," follows the career of Mr. Harold Brown from newspaper reporter through his "induction" into the profession of advertising engineering. It would seem that he was cut out for it. Either he learned with a speed hardly short of miraculous or else advertising engineering may be mastered in a much shorter space of time than engineering in the commoner branches. Had he, for example, become an automobile engineer, a constructing engineer or a civil engineer instead of an advertising engineer and progressed as rapidly, he would have been building motor cars, skyscrapers, steel bridges, or railroads within a year."

We are glad to see engineering becoming so popular, but we hope that the new-coming class will not totally supplant the old. No doubt Soup Engineering and Baked Bean Engineering will soon be featured in the advertising pages of our popular magazines. At present, as is well known from the advertisements, our beans are baked by chemists, who analyze each bean as it goes into the can. Why wouldn't a good engineer be fitted to superintend the ovens, or, as they might be termed, roasting furnaces? Or even—but this is too much to expect—a good cook?—Editorial in Engineering and Mining Journal.

Repairing Ore Dock Chutes By Oxy-Acetylene Welding

In 1917, 1918 and 1919, experimental repairs of the lining of chutes of ore docks were made by the Great Northern R. R. by means of the oxy-acetylene method. The results of these experiments are given in a report of the Committee on Maintenance of Timber Docks, submitted Oct. 27 at the 30th annual convention of the American Railway Bridge and Building Association.

During the winter of 1917 four chutes which were badly damaged and which required repairs, were removed and sent to the Superior shops of the railway where they were repaired by patching with the welding system. After the chutes had gone through a season's run, an inspection of them showed that the repairs which had been made in this manner were satisfactory and the chutes were still in good condition.

It was then decided that inasmuch as this system was a success, the work could be done more economically by leaving the chutes in place on the dock rather than removing and forwarding to the shops and after being repaired, returned and again put in place on the docks. In the winter of 1918 and 1919, with an oxygen-acetylene welding outfit on the docks, furnished by Contractors Peppard & Fulton who did the repair work that year, they repaired an average of five chutes per day, which included the cutting out of the defects and welding in the new plates. The patching plates were delivered to the docks cut to various sizes, and the average consumption of gases for so repairing five chutes was one tank of acetylene and 2½ tanks of oxygen.

During the winter of 1919 and 1920 repairs were made in a similar manner, but due to the severe cold weather while this work was in progress, and the apparent scarcity of gas, an average of only three chutes per day was made. However, the repairs made during this time were more extensive than previous, the patching plates being larger and the plates were also cut to size on the job, which work had been previously done at the shops.

The plates for patching small holes were cut triangular in shape and one point placed against the run of ore.

The following is the amount of labor and material, together with the cost of same, for making repairs to five chutes under favorable weather conditions and with sufficient material on hand:

285 cu. ft. of acetylene gas at $0.02½ per ft	$7.12
550 cu. ft. of oxygen gas at $0.01¾ per ft. ...	9.62
10 lbs. ⅛ in. ox-weld rods at $0.14 per lb..	1.40
150 lb. ¼ in. thick sheet steel at $3.40 per cwt	5.10
Welder, 10 hr. at $0.80 per hr. ..	8.00
Helper, 10 hr. at $0.60 per hr..	6.00
	$37.24

This will make an average cost per chute of $7.45, which is considered very economical and efficient. If extensive repairs are contemplated, the cost could be reduced materially by placing two welding crews on the job, one to do the cutting and the other to do the welding.

Methods of Filling Railway Trestles and Bridges and Maintenance of Structures During the Work

When construction work on a new line of railroad is begun every possible effort is made to expedite the laying of the track in order to permit the operation of work trains for the handling of men and materials and thereby hasten other construction work, and also to permit the operation of revenue trains. In order to accomplish this more quickly waterways, ravines and various depressions are crossed by means of timber trestles, which are then used as long as they can be maintained economically. The timber trestle has the advantage that it can be built quickly and time is available during its life to enable a study of the situation to be made in order to determine the type of permanent structure that should be built for the necessary waterway or other opening. Wherever possible, timber trestles are replaced by earth embankment because this forms the most efficient roadbed. Thus it is that almost all railroads have programs of bridge filling each year. A study of the methods of filling these structures has been made by a committee of the American Bridge and Building Association. The results of this study are embodied in a committee report submitted Oct. 27 at the 30th annual convention of the association. The report practically in full follows:

It is sometimes possible to begin the filling within a year or two after the pile or timber trestle is first built by putting in from 18 to 24 in. of earth in ravines each year, thereby gradually filling the opening and also serving the further purpose of preserving the piling, which rots at the ground line, by carrying this line a few feet higher up on the pile each year before decay has had time to injure it. When this method can be followed the structure will not be disturbed during the process and no extra precautions need to be taken.

In cases where the filling must be done more rapidly, it is necessary to take precautions to see that the bridge structure is at all times safe for the operation of trains. Before the filling is begun the structure should be gone over carefully and, if necessary, strengthened, and as many of the longitudinal members as can be spared should be removed as the work progresses, as they are in the way of filling material. As the filling material is placed, it should be spread uniformly around and under all parts of the structure and compacted as thoroughly and evenly as may be between the trestle bents to avoid crowding them out of line. It has been recommended that, as this material is spread, the outer edges should be kept higher than the center to prevent the washing of the slopes, and also to aid in the settlement of the filling, but whether this need be done or not will depend largely upon the nature of the filling material. The material used for filling may have much to do with the progress of the work; in some cases it may be best to fill the trestle partly and allow several months to elapse for the settlement of this portion before proceeding with the balance.

There are various methods of filling bridges and the one to be used will depend upon local conditions, such as the topography at the bridge site and the accessibility of suitable filling material. The best kind of filling material is that which will pack solidly, is not liable to slip or slide and will not wash away easily during heavy rains. The distance from the bridge to the location of suitable filling material will largely determine the method to be employed. If suitable material can be obtained from borrow pits adjacent to the bridge and the topography of the ground permits it, the best method of filling is by team because in this way the accumulation of earth around the trestle bents is comparatively slow, it can be properly distributed to avoid disturbing the bridge structure and the men and horses employed in handling the earth do much to compact it in passing over it.

Usually suitable material must be hauled from a distance. If this distance is not too great, the material can be handled by dump cars operated on a temporary track, built parallel to the operated track, and the cars may be loaded by team shovel or drag line and hauled to the bridge by horses or small engines. If the distance is too great for this, the material is usually loaded into railway cars by a steam shovel, hauled to the bridge by train and dumped through the bridge structure. There may be situations in which the lower part of the filling can be placed by teams and the upper portion by train but, as stated before, this will be determined by local conditions. In other cases also bridges may be filled by wasting the material secured from ditching operations or the waste from mines or other industries; at other times a gradual filling of trestles is brought about by the accumulation of city refuse, cinders, slag, etc. In mountain districts it is sometimes possible to fill trestles by the hydraulic or sluicing method, and when this can be done it is very satisfactory and economical.

Because the methods employed and the difficulties encountered are largely determined and governed by local conditions, it is thought best to recount the practices on different railroads and to tell the stories of individual pieces of work. The committee has therefore collected a number of short monographs from different members of the association which follow:

Experiences on the Missouri Pacific Ry.—R. J. Bruce, in telling of his experiences, states that on the Missouri Pacific some trestles 90 ft. high have been filled, which required more than 250,000 cu. yd. of filling at which only a small gang of men were needed to maintain the structure during the work and these only to replace longitudinal and other members broken by falling earth. The bridges were carefully overhauled beforehand and the filling was done by dump cars under the supervision of a competent bridge man who did not allow the earth to be dumped in a haphazard manner. He also recites that in other cases filling has been done in a manner that started movement in the bents, with the result that a large force of bridge men was required almost constantly until the stringers were removed after settlement of the embankment as much as a year later. In another case a trestle was filled in which the pile bents stood in 40 ft. of water, the bridge crossing a bayou caused by a break in a levee in which 70-ft. piling has been used. At this point a filling was started by a work train gang without investigating the bottom. As it happened, the bottom sloped across the line of the track, with the result that the bents began moving sideways until they finally landed entirely outside of the track and the stringers had to be carried on cribbing. Had soundings been taken this condition would have been discovered and the filling could have been so placed as to avoid the movement of the bents, thereby saving much expense and delay. This demonstrates the need of a preliminary study of the situation and the application of good judgment by a man experienced in this line of work.

Experiments on the Missouri, Kansas & Texas Ry.—A. S. Clopton, supervisor of bridges and buildings, gives a history of several cases and methods employed, as follows: As a general rule the best method of filling bridges is with teams but whatever the method the fill should be brought up level and uniformly to avoid crowding the bridge out of line, thereby making the job more difficult and increasing its cost. This is true whether the bridge is high or low. When filling is begun the sway braces should be removed from the bents and as the dirt is deposited men should be on hand to cast it around the piles or bents in order to keep the bridge from crowding out of line. On high bridges the lower sway braces and horizontal braces should first be removed to enable teams to drag the dirt between the piles or posts. As the filling progresses the higher braces are taken out as fast as they interfere with team movement. When the filling is done with steam shovel it is best to distribute the dirt with men and teams as above except in cases where the steam shovel is located near by and the dirt trains come in so rapidly that there is insufficient time between trains.

The filling of a high bridge can be made better by having one or two water cars with several outlets pass over the bridge after the dumping of each train load, thoroughly wetting the dirt, causing it to settle more quickly and avoiding later bad effects. When filling with steam shovel and dirt cars is begun, every alternate trestle tie should be removed, permitting the dirt to be distributed more easily in the center of the bridge. As the filling nears the top the guard rails are taken out and a temporary guard rail is provided by spiking a 2-in. by 6-in. or 2-in. by 8-in. timber on the ends of the ties, thus holding them in place. This is done to permit the use of a spreader that will not clear the ordinary 6-in. by 8-in. guard rail. In filling high bridges with steam shovel material it is important that a good class of earth be selected, avoiding such as will not pack readily or such as contains quicksand or slides when wet. The best material is secured from shale or clay banks.

After the filling has been completed the writer believes that the stringers should be removed immediately, although many think best to permit the fill to stand for several months or perhaps one or two years to allow for settlement. In my opinion no matter how long the fill stands there will be a slow piece of track at this point for some time after the stringers are taken out, and my experience indicates that the sooner the timbers are removed the sooner the track will get into good condition.

Several plans may be used successfully to remove the stringers. One of the best is to pull the chords with a derrick, employing the following or similar methods. When ready to remove the stringers on a long fill, first deliver the requisite number of track ties and spikes on the ground. Use one gang of from 8 to 12 bridgemen and another of from 20 to 30 track men or more if the job is a big one. The chords should then be cut into sections of 60 to 75 ft. The track is then lifted from one section, all of the bridge ties removed and the derrick line secured to one end of the chord, raising it about 6 ft. The chord is then dragged by a work train to a point where it is convenient to remove the bolts and load the material. After both sections of the chord have been dragged out in this manner all available men are used to cast dirt in the space, filling it to the required height, which should be at least 6 in. above the original track level. The track ties are then placed and tamped with shovels. This plan of operation is then repeated on the next and following sections. After all of the stringers are removed the track at each end should be raised on dirt from 6 to 12 in. above the original level and the bank dressed off to prevent damage from heavy rains. The track at this point should be carried on dirt for several months if possible and cinders or other ballast should not be placed on the bank until several soaking rains have fallen on it. In most cases it is necessary to protect the section of track with the usual slow orders and flags and sometimes a watchman should also be employed constantly. The track foreman should visit the place daily until the track is in safe condition.

When a derrick is not available for pulling the stringers or on short bridges where it is not neded the best plan is to remove the chord bolts when the filling has reached a level at or near the bottom of the chords because it can be done more quickly than after the filling is completed. The stringers are then taken out singly by hand. A safe and economical plan is to dig a trench about 12 in. wide alongside the outer chords down to the top of the caps, and place track jacks between the chords to spread them out until each outside stringer will clear the ends of the trestle ties. In the meantime dirt should be cast between the chords, keeping this space well filled and tamped. The outside stringer is then lifted out and the same plan repeated until all of the stringers have been removed, but in no case should a stringer be left on one side with all of the stringers out on the opposite side when permitting a train to pass over it. After the stringers have all been taken out the bridge ties are removed and replaced with track ties and the track raised as outlined previously. Either of the above plans will not seriously interfere with traffic and both have been used with satisfactory results on lines having many trains a day.

Specific Cases on Missouri, Kansas & Texas Ry.—A bridge near Stoutsville, Mo., on the north approach to Salt River with a height of about 20 ft. and a length of about 1,016 ft., was filled about 1895 with a steam shovel, but owing to the class of material used which contained some potter's clay the fill did not stand up and settled about 12 ft. It was then filled with teams, the stringers being removed about 1896-97. This filling also failed to stand up and it was necessary to redrive the bridge and renew the deck. It remained in this condition until 1911 when it was again filled with a steam shovel and work train, hauling shale from coal mine banks. The stringers were removed in the latter part of 1912 and no trouble has been experienced since.

A bridge near Pleasant Green, Mo., with a height of 52 ft. and a length of 1,023 ft., consisting of frame bents on stub piles was filled with teams during the latter part of 1910, the filling being brought up within 8 ft. of the base of rail and then completed with a steam shovel, using mine shale. In this case as the team filling progressed the sway braces, lateral braces and horizontal braces were removed from the bents, and as the dirt was wheeled in, sufficient men were on hand to cast the dirt around the posts and bents. Immediately after the steam shovel material had been placed the stringers were removed. The fill settled about 2 ft. during a period of 8 to 10 months after the stringers had been removed, and it was necessary to haul in considerable more mine shale in order to keep track up to proper surface. There were also several slides near the south end of the fill which were not, however, very serious; these were overcome by trenching the fill at these points, putting in several French drains. This work was completed about 1913 and no trouble has been experienced since that time.

A pile and frame trestle bridge near Okesa, Okla., with a height of 11 ft. and a length of 768 ft. was filled in 1910 with a steam shovel from a bank near by, the material being about 50 per cent clay, 30 per cent shale resembling slate and 20 per cent shale rock, the bank being so hard that it was necessary to blast or shoot it for the shovel. None of the braces were removed from the bents in this case during the process of filling. The fill was permitted to stand about 12 months before the stringers were removed. From time to time the bank settled about 6 ft. to 8 ft. in the center of bridge and it was necessary to haul in ballast material in order to keep the track in proper surface. The ballast in this case was cinders. There has been no trouble on account of the bank settling during the past five years.

A pile and frame trestle bridge near Nelagoney, Okla., with a height of 15 ft. and a length of 312 ft. was filled during the latter part of 1911 with a steam shovel, using material from a bank near by, the class of which was about the same as in the foregoing paragraph. None of the braces were removed. Immediately after the filling was completed the stringers were removed and the filling settled about 6 ft. to 8 ft., the track being kept in proper surface by placing ballast from time to time for a period of about 2 years. No trouble has been experienced during the past 4 or 5 years.

A bridge near Stoutsville, Mo., with a height of 59 ft. and a length of 294 ft., was filled in 1916 with a steam shovel, the material being sandy loam and soft sand rock. While the filling was being dumped in the bridge, a 2-in. stream of water was kept flowing onto it almost continually, virtually puddling the dirt as it was placed; the stringers were removed immediately after the filling, and no trouble has been experienced since.

A frame trestle bridge near Stoutsville, Mo., with a height of 64 ft. and a length of 355 ft., was filled in 1918 with the same class of material as above (sandy loam) with a steam shovel. Some water was also deposited on the fill during the process of filling but not sufficient to properly puddle or settle it, which caused the fill to settle 2 ft. or 3 ft. The stringers were removed immediately and very little trouble has been experienced since.

A pile trestle bridge near Carney, Okla., with a height of 35 ft. and a length of 115 ft., was filled by teams October and November, 1919, with a red sandy soil. Immediately after filling the timbers were removed, and no trouble was experienced, trains operating over this fill on the original dirt filling at the usual speed.

Experiences on the Pennsylvania System.—T. L. Lowdermilk, master carpenter on the Sunbury Division of the Pennsylvania R. R., describes several problems on that road as follows:

Bridges and trestles under 50 ft. in height, can be filled the center of the track, allowing the fill to run out each way. To keep down the cost of maintaining the structure while filling, bridges 50 ft. and over in height should be filled from the outside, allowing the filling to roll to the center of the spans of its own accord, keeping the fill on each side of the bridge to about a uniform height and of the same kind of filling. A very good way to make a fill of this kind, is to use side dump cars operated by air.

A wooden bridge on the Pennsylvania System, at Morea, Pa., of a height of 52 ft. and a length of 120 ft., was filled with mine rock and clay, using side dump cars and dumping on each side to a uniform height, allowing the fill to run to its own level to the center of the track. This bridge was filled without any interruption to traffic or any moving of the trestle work whatver and with no extra maintenance cost. The diagonal bracing was removed during the progress of filling, as was also all bracing that was liable to hold the fill, allowing the fill to bed itself.

During 1911 on the Pittsburgh Division, a bridge of steel construction located at South Uniontown, was filled. This bridge was erected in 1900 with steel tower construction and girders. The height of this bridge was 110 ft., and the length

460 ft. The filling was of clay and rock to within 10 ft. of the base of rail, and the balance of the filling was cinders. This fill was made with dump cars and bridging built under bridge, throwing the fill at the bottom about 50 ft. from the center of the track at the start and allowing it to roll to the center by dropping the filling on each side. The solid packing of the fill was done outside of the towers. This steel structure was filled under traffic without any obstructions except pushing the track out of line about 6 in.

Methods Employed on the C. M. & St. P. R. R.—The following methods employed on the western lines of the C. M. & St. P. R. R. are described by J. F. Pinson, District Engineer: Bridges are ordinarily filled by one of two methods. (1) If the filling material is secured from borrow pits near the bridge it is placed by teams and scrapers or by small dump cars and in this case little maintenance work is required on the bridge structure because the material is placed in small quantities and thus avoids rapid settlement while it is not likely to push the bents out of alignment. (2) When bridges are filled by train haul considerable maintenance may be required, especially for long and high structures, because the filling is placed rapidly and the uneven settlement causes the bridge to settle out of line and surface.

Where filling material is of coarse gravel or loose rock considerable damage may often result to braces, intermediate sills and occasionally to posts. Where material is to be placed by train, it is usually handled in standard ballast cars and unloaded by plowing off, or in air dump cars which tip sideways in unloading. When plowed off it is apt to do less damage to the bridge than when unloaded from air dump cars for the reason that it is unloaded in smaller quantities, and more uniformly. In unloading air dump cars the entire load (usually 12 yd.) is dumped at once and falls in one place. On high bridges this frequently causes damage to braces and sills. High bridges are usually strengthened by placing additional mud blocks and additional posts under the lower sills and the ends of lower and intermediate sills can be protected by placing wedge-shaped blocks against the posts on top of the sills. As the filling progresses the tower and longitudinal braces should be cut or removed so as to avoid pulling the bents out of line due to the weight of dirt on the braces. Where material is placed from air dump cars considerable protection can be provided to the substructure of the bridge by the construction of aprons to throw the dirt away from the bridge. This can be done by placing 12-in. by 12-in. timbers parallel with the track on top of and near either end of the caps, the outer edge of the 12-in. by 12-in. timbers to be beveled so as to permit the placing of 4-in. by 12-in. by 36-in. planks at right angles to the 12-in. by 12-in. timbers. Another method which has proved equally good or perhaps better is to use old 10-in. by 18-in. stringers notched over the caps so as to have the long side of the stringer act as the apron and omit the 4-in. by 12-in. planks. Where the foundation of the bridge is very soft and excessive settlement occurs a grillage of old stringers can be placed on top of the caps and the regular floor of the bridge supported on this by blocking between the stringers and the grillage. In this way the bridge can be maintained in proper line and surface more easily than by blocking or wedging under the stringers on top of the caps.

During the past 10 years we have filled a large number of timber trestles from 10 ft. to 110 ft. in height and up to 1,800 ft. in length. By following the methods outlined above we were able to maintain these bridges safe for the operation of trains at all times and at a minimum expense.

In addition to the above methods, that of sluicing is sometimes employed. In order to make sluicing successful it is necessary that the yardage be large and conditions favorable for sluicing the material from adjacent hillsides by gravity water pressure. Filling can be placed in this way with minimum damage and maintenance to bridges and will also permit the immediate removal of stringers, as a fill made in this way settles in the making. In the Bitter Root Mountains of Idaho this company filled a number of large timber trestles by sluicing. In doing this work it was necessary to construct several miles of timber flumes to convey water to the bridge sites. Water was delivered from flumes through 8-in. steel riveted pipes to nozzles under heads of 250 ft. to about 400 ft. The sluiced material was conveyed to the bridges through wooden troughs, the minimum grade of these troughs being 1 ft. in 4. By this method it is safe to place the filling as fast as equipment will permit. In filling by train the material can also be placed as fast as equipment will permit if proper precautions have been taken to take care of settlement and braces and struts are removed as the filling progresses.

Ordinarily for high fills the stringers should not be removed until about six months after the filling has been completed. However, we have had cases where bridges were filled with gravel and loose rock and stringers were removed within 3 days. The kind of material used for filling and local conditions such as rainfall, etc., will determine the length of time necessary before stringers should be removed.

Experiences on the Bessemer & Lake Erie R. R.—The following is the experience of H. T. Potter, Chief Engineer: In filling a steel viaduct 86 ft. high, with material excavated from a clay and shale cut, it went out of line 3 ft. 10 in. at the worst place. We know that there was no settlement in this bent because the pedestals were a part of the side wall of a 26-ft. arch and there was no cracking or disturbance of the pedestals. We never came to any positive conclusion as to why these bents went so far out of line, but thought it was probably due to the fact that the afternoon sun on one side of the embankment caused the fill on one side to settle more rapidly than on the other side. This work was done in mid-winter. After this we filled several viaducts from 80 to 90 ft. high and only used waste filling from the steel mills. These did not give us any trouble.

In filling a viaduct, with waste filling from the mills, at the north end of our Allegheny River bridge, which viaduct ran from 120 to 140 ft. high across the bottom, we were unable to unload the filling from the viaduct over which we operated on account of causing too much interference with traffic. We erected another viaduct alongside it, on 32-ft. centers, out of steel from a viaduct which had been taken down on account of a change of line, and unloaded the filling from the temporary viaduct. The towers of the temporary viaduct were placed between the towers of the viaduct over which we operated, and in this way we were able to get the 32-ft. centers. The viaduct over which we operated, went out of line about 1 ft. one day, so we had to stop the filling. We dug down to find out what the trouble was and it was found that the columns were made out of two 15-in. channels which were latticed and that the pressure of the fill had squeezed the two channels nearly together, the lattice work bulging out. We suspended filling for a year until the new bridge over the river was complete when we were able to use the temporary viaduct to run our trains over which allowed us to fill from the viaduct over which we formerly operated. In order to prevent the channels from squeezing together we drove in short pieces of 3-in. plank of the proper width at points where the top of the fill already made was still 50 ft. and over from the top of the viaduct. We were able to finish filling the viaduct without further trouble.

Filling on the Philadelphia & Reading Ry.—A report of bridge filling now in progress on the Philadelphia & Reading, by Franklin Gable, foreman carpenter, follows:

In the past we have repeatedly filled wooden trestles, ranging from 12 ft. to 40 ft. in height and experienced little or no trouble. Recently, in line with the general movement in equipping our lines with heavier power, it was decided to replace several steel viaducts on the Catawissa railroad with fills, providing culverts for the streams and roads. Five bridges were filled and abandoned: Dark Run viaduct, Stranger Hollow viaduct, Long Hollow viaduct, Mine Gap viaduct and Fishers viaduct. These viaducts were from 20 to 23 years old and built under specifications corresponding to Coopers E-40 loading. The general arrangement of bracing, etc., followed one type throughout. This is a single track railroad with heavy freight and coal traffic, the passenger service being limited. While it is possible to divert traffic to other routes on this division, this is only done at considerable loss so that it is almost imperative to maintain an uninterrupted train service. At first the filling of the bridges on this district was undertaken in much the same manner as was done in the case of the wooden trestles. A train of loaded cars was pulled on to the bridge and the doors released, allowing material to run from cars through the bridge floor.

Work was first started at Dark Run in November, 1916. This was a steel viaduct 568 ft. long between back walls, 52 ft. plus or minus from the base of the rail to the top of pier foundation, and consisted of a series of deck plate girder spans supported on steel towers, spanning a hollow carrying a road and a brook. A concrete box culvert was provided for the road and a 4-ft. concrete box was provided for the brook. Every third or fourth tie in the bridge floor between the rails was cut out, the work train placed cars over the entire length of the bridge and the filling material was allowed to drop through the bridge floor, thus raising the fill uniformly through the entire length. No trouble was experienced and the work was completed in June, 1917.

Following the general program, the work of replacing Stranger Hollow viaduct was started August, 1917. This was a steel viaduct 424 ft. long to back of abutments and 94 ft. high to base of rail. In this viaduct there were two main Warren deck truss spans 85 ft. in length, the tower spans and approach spans being deck plate girders ranging from 30 to 75 ft. in length. This bridge spans a V-shaped ravine carrying a small brook. A concrete box culvert was placed to provide waterway for the brook. The method of filling was the same as followed at Dark Run and was carried on without interruption up to within 10 ft. of the base of rail. At this point the longitudinal bracing of the towers began to buckle. The filling was pushed rapidly and the work was completed, it being necessary to block up the track on the fill for about the last 5 ft., and maintain the alignment and surface of the track, the track being lifted entirely off the steel bridge.

The filling at Long Hollow viaduct was started in March, 1918. This was a bridge of the same character as that at Stranger Hollow. It was 746 ft. long between back walls and 129 ft. high. There were four Warren deck spans 85 ft. and one 75 ft. in length, and the remaining spans were of deck plate girders. The deck plate girder spans were at one end of the bridge and were supported on bents ranging from 23 to 40 ft. in height. The main truss spans were supported on steel towers.

A concrete arch culvert was provided for the stream. The work of placing this culvert was delayed and it was necessary to place a small portion of the fill while the work of concreting was still going on. However, the fill thus placed was not over 50 ft. high. The fill was carried to a uniform distance as measured from the base of rail until a height of 50 ft. was reached, the material being dumped from the cars in the same manner as at Stranger Hollow and no attempt being made to spread the fill transversely, care being exercised to see that no large material was allowed to strike any of the steel work of the bridge. It is understood that normal traffic was allowed on the bridge, the only precaution taken being to maintain a slow order of 10 miles per hour. In March, 1919, when the fill had reached a height of 50 ft., it was noted that the bracing in the towers was showing signs of failure, also at the columns of the towers which was made up of two 15-in. channels latticed failed, going vertically out of line, the alternate lateral bars buckling.

This necessitated placing bents at tower No. 2 from the north end where the failure occurred. Work was pushed rapidly. However, in March a later inspection showed that several other columns of the high towers were showing signs of bending. It was then decided that the safe thing to do was to erect timber bents to take the load from the steel work of all the high towers. Traffic was prohibited from crossing the bridge during the time that these bents were being placed. After the bents were erected light engines and traffic were allowed. V-shaped inverted troughs were placed in all spans to spread the fill transversely. However, this method was not entirely effective. The wooden bents, on account of having a soft foundation on the new fill, frequently went out of line and it was necessary to follow the matter closely. However, the filling was completed in November, 1919.

On account of the trouble experienced at Long Hollow and Stranger Hollow it was considered advisable to strengthen the towers preliminary to placing the filling at Mine Gap viaduct, a structure 589 ft. long and 105 ft. high, the clear height of the tallest bent being 93 ft. A method of supporting the bracing by means of timber frame was suggested but it was deemed more advisable to place concrete reinforcement.

Lateral longitudinal concrete struts were placed at the tops of the concrete columns. The work is now in progress. Little trouble has been experienced, the fill having reached a height of 25 ft. from the base of the rail. It is to be noted that a concrete arch was provided for the creek in the ravine which this viaduct spans.

At Fishers viaduct, plans have been drawn for a reinforcement of the columns with a reinforced concrete encasement and the work is to be carried out along the same line as at Mine Gap.

In determining the advisability of strengthening the framework of bridges preliminary to filling, local conditions and the extent of the work will necessarily govern the method of procedure. It is agreed that if it is possible to spread the fill to its ultimate line from start to finish and also to allow time for the material to settle the difficulties will be reduced to a minimum, although even then if the natural topography is such as to give rise to steep slopes and if the material used at different stages of the fill varies in weight and character some slip in the fill may occur. In many cases it is not economically practical to consider spreading the fill to its full base at the start and if means can be devised whereby the structure can be stiffened to such an extent that the material can be dumped with little spreading necessary, a saving will be effected.

The work at Mine Gap called for the placing of 16 concrete columns, 33 in. in diameter as follows:

Yards concrete required	No. hoops required.	Length of steel column	Length of concrete column
34	48	71 ft. 11 in.	47 ft. 00 in.
34	48	71 ft. 11 in.	47 ft. 00 in.
35	54	77 ft. 00 in.	53 ft. 00 in.
35	54	77 ft. 00 in.	53 ft. 00 in.
37	59	82 ft. 1 in.	58 ft. 00 in.
37	59	82 ft. 1 in.	58 ft. 00 in.
38	62	85 ft. 2 in.	61 ft. 00 in.
38	62	85 ft. 2 in.	61 ft. 00 in.
40	68	94 ft. 3 in.	69 ft. 00 in.
40	68	94 ft. 3 in.	69 ft. 00 in.
39	64	87 ft. 2 in.	63 ft. 00 in.
39	64	87 ft. 2 in.	63 ft. 00 in.
35	52	74 ft. 8 in.	51 ft. 00 in.
35	52	74 ft. 8 in.	51 ft. 00 in.
34	45	67 ft. 11 in.	44 ft. 00 in.
34	45	67 ft. 11 in.	44 ft. 00 in.

Note.—Allow 9 ft. of ¾ in. steel for each hoop (diameter 29 in., lap 18 in., plus or minus).

The vertical reinforcing rods were first placed, using a template at the top and bottom to hold the rods in their correct vertical position. A gang of four men was assigned to place the ¾-in. hoops which were spaced at 12 in. center to center on the vertical rods and wired thereto with stove pipe wire. While this work was going on the forms for the footings were made and placed and the concrete poured in the footings.

Another gang was assigned to erecting scaffold which consisted of heavy 12-in. by 12-in. timber at each stage of the bracing in the tower. Sectional forms were placed about the column half sections to pass the bracing, the other side being filled out with laggings. The concrete mixer was located at one end of the bridge on top. A narrow gage track for a small concrete hopper truck extended the full length of the bridge, being carried on outriggers from the ties.

The sectional forms for the columns were placed for a height of approximately 20 ft. The concrete was carried from the mixer on a small hopper truck which dumped at the level of the track into a portable iron chute which in turn was zigzagged down the tower to the forms. The forms were allowed to remain on the concrete for one week before transferring them to the next tower. Handling the work in this manner, the time required to complete it was nine weeks, some delay being experienced on account of delayed shipments of material.

It is estimated that 240,000 cu. yd. of material will be dumped at Mine Gap. The cost per cubic yard of dumping this material was increased approximately 5 ct. or about 16 per cent. To offset this there is the advantage of non-interference to traffic and the 16 per cent is a maximum, since the material can be dumped without delay on account of any work on the structure going on during the progress of the fill.

From the data and experience at hand, we are led to the conclusion that with only the ordinary easy precaution of maintaining a uniform longitudinal height, structures of this character less than 50 ft. in height can be filled without experiencing any considerable trouble. This may not hold true for pile trestles.

The character of the fill is an important consideration. The best results will no doubt be obtained by using uniform material. Industrial waste was used in filling the bridges referred to and gave rise to difficulty in unloading and also danger of the larger particles such as slag striking on the bracing when dropped. In the case particularly of ashes or cinders, precaution must be taken against fire, which may occur in either of two ways (1) the fire may be in the cinders as dumped or (2) the unburnt material present may take fire in the fill through spontaneous combustion when dumped in quantity.

In this connection it may be well to make note of the Jordan bridge on the Castasauqua & Fogelsville railroad. In this instance the bank took fire, causing the collapse of the steel towers which supported a series of bridges crossing a valley 90 ft. below grade. This occasioned temporary trestling and considerable maintenance to permit traffic to be carried until the entire bridge was finished.

In greater heights than 50 ft. the fill should be maintained at a regular height longitudinally and also should be spread transversely for a distance well beyond the legs of the towers.

If possible all structures crossing the fill should be completed prior to beginning the filling in order that no deviation will be made in keeping the fill at a uniform height.

Due to the settlement and shrinkage in the fill which is considerable, the excessive weight brought on the bracing will cause it to fail and likewise cause a collapse of the columns. Therefore, it is necessary that the columns in all cases be strengthened and that the bracing, if possible, be supported or removed as the fill progresses and that stiff concrete or suitable longitudinal and transverse struts be provided. End filling should not be attempted on account of the longitudinal forces set up against the towers and also on account of the unequal pressure brought on the arches or culverts crossing underneath. In all cases a slow order of [illegible] miles per hour should be rigidly maintained in order to keep vibration at a minimum.

Practice on the Duluth, South Shore & Atlantic R. R. This is described by G. A. Manthey, as follows: "The usual method of filling high trestles if suitable material can be found near the job is to use small dump cars, but if it has to be hauled any distance it is loaded on flat cars and unloaded with a plow. During 1913 and 1914 a bridge on the South Range Extension, Mineral Range R. R., was filled. The bridge was 1,099 ft long and 62 ft. high and on a 2 curve. The filling was done with flat cars and a steam shovel. Shortly after the filling was started, trouble was experienced with broken tower braces and the bridge went out of line. To overcome this, it was necessary to place an apron on the sides of the bridge, the top being flush with the ties. As the filling was unloaded heavy pieces were thrown out to clear the bracing. As the bridge had a tendency to travel with the curve, a side plow was used to keep the filling higher on the outside than on the inside of the curve. As the filling progressed a man with a horse and scraper was stationed at the bridge to keep the material leveled off under the bridge and to fill in around the plumb and batter posts. As the bridge was 13 years old some trouble was experienced with broken caps and sills. The caps were renewed and the sills covered deep with filling, a block was batted on the plumb and batter posts and a cross sill installed on the mud blocks. It was not found necessary to reinforce this trestle either before or during the work. To prevent lateral movement of the bents the sway and tower bracing was kept securely spiked, sash bracing was added where necessary, and these were all renewed if broken by falling material. The stringers on this bridge were removed two years after the completion of the filling.

Resocketing Wire Rope.—As the vibration in a hoisting rope comes to a sudden stop at socket, the wires at that point ultimately become crystallized. Moisture is also apt to concentrate around the socket, with the result that intensive corrosion develops. To maintain safety a section of rope next to a socket should be cut off at intervals and the socket reattached to the rope. This resocketing, states "Leschen's Hercules," should be done at least every six months, and under many conditions every three months.

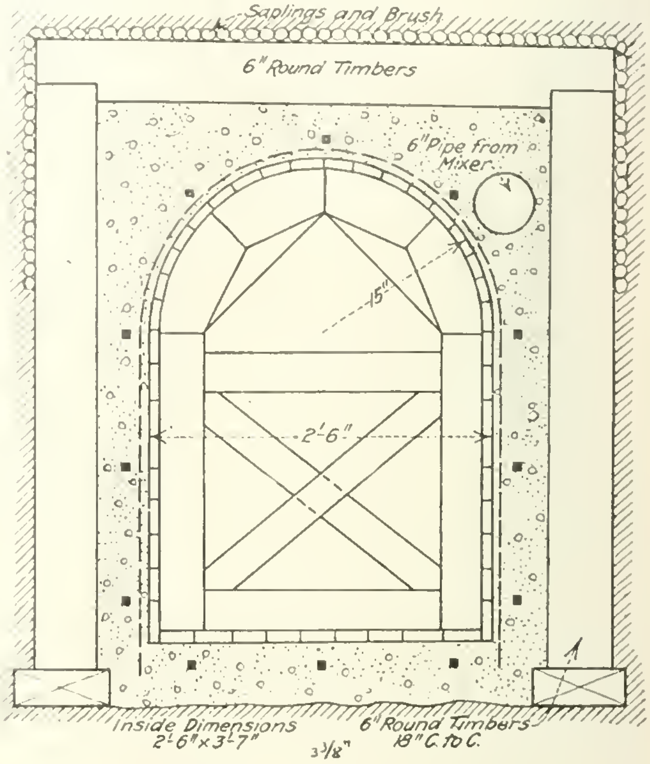
Railway Electrification in Spain. The Spanish government has decided to push forward the work of electrifying the railroad line between Palencia and Gijon. This line when completed will provide transportation for the coal produced in the Asturias region.

Ties from South America. The Pennsylvania R. R., according to a press report, is investigating the adaptability of South American hard woods for cross ties.

Concreting Small Tunnel Under Difficult Circumstances by Pneumatic Method

An interesting job of lining a small tunnel for the Marquette Cement Mfg. Co. was recently accomplished with a pneumatic mixer. The finished tunnel was 2 ft. 6 in. wide and 3 ft. 7 in. high with a semicircular arch and flat bottom.

The tunnel was excavated about 5 ft. 9 in. wide by about 5 ft. 3 in. in height in rectangular section and the excavation was supported by sets of 6-in. round timbers every 18 in. Brush and saplings were used to span the roof and side spaces between the timber sets. The timbers took up considerable space so that when a section of forms were set with reinforcing steel in place over the forms, there was not sufficient room left over the top of the form to admit the 6-in. pipe from the pneumatic mixer.



Sketch of Section of Tunnel.

It was therefore decided to place the pipe delivering the concrete at one side over the haunch of the arch and depend upon the force of the pneumatic delivery for forcing the concrete into the roof behind the cross timbers and also on the opposite side of the form and under the floor. It was anticipated that possibly there would be some spaces left behind the cross timbers and so grout pipes were placed in positions which would lead to the more difficult places and through which grout could later be forced if found necessary. As a portion of the tunnel was located within a foot underneath the foundation of heavy machinery it was necessary to have full thickness of concrete at all points.

The concrete pipe was carried through the tunnel suspended from the roof timbers, but as these were not true to grade it was not possible to keep the pipe up against them as desired and at the entrance into the forms the pipe was at times as much as 1 ft. below the roof timbers.

The forms were made 30 ft. long and the pipe carried half way or about 15 ft. back over them for beginning the concreting. The concrete was blown back against the far end and gradually filled the end and sidewall directly under the pipe, and also flowed under the floor forms and in the side wall toward the forward end. As the concrete in the rear built itself up it also was forced over the arch and flowed down on the opposite side of the forms and filled the wall on that side. When the concrete had filled up so that it was necessary to remove a section of delivery pipe the form was approximately three-fourths filled. The pipe was then terminated at the front of the forms and the balance of the concrete was shot in from that position.

The concrete was made just wet enough to flow easily but care was taken not to provide too much water. The forms were small and the concreting operation rapid, so that within an hour or two after beginning concreting the forms were filled solid full.

It was found after removing the forms that the spaces behind the timbers where grout pipes were left had been solidly filled and it was decided that the grouting which had been originally contemplated was not necessary.

The pneumatic mixer was furnished by the Concrete Mixing & Placing Co., 12[illegible] W. Madison St., Chicago, who also furnished an experienced man to supervise the operation.

Progress on Welland Canal Construction

The present status of the work on the Welland Ship Canal, Canada, was outlined by Mr. Alex. J. Grant, engineer in charge, in a paper presented Sept. [illegible] at the General Professional meeting of the Engineering Institute of Canada.

The estimated cost of the Ship Canal in 1912 was $50,000,000. The expenditure to March, 1920, including cost of surveys, engineering expenses, and right of way was $20,270,436. The quantities of several of the main items involved in the construction of the canal are as follows:

Earth excavation, cu. yd.	38,500,000—40% completed
Rock excavation, cu. yd.	6,600,000—23% completed
Water-tight embankments, cu. yd.	3,400,000—59% completed
Concrete, all kinds, cu. yd.	2,600,000—20% completed
Steel reinforcing, lb.	16,500,000—36% completed

For the purposes of construction the canal has been divided into nine sections. Section No. 1 is at the Lake Ontario end of the canal, and Section No. 9 at the Lake Erie end. During the fall of 1913, Sections Nos. 1, 2, 3 and 5 were placed under contract. The first three sections include the Lake Ontario entrance, the seven lift locks, guard gates, eight bridges, and the canal prism between the Lake and Thorold. Section No. 5 embraces the deepening and widening of the "Deep Cut" on the summit level between Allanburg and Port Robinson.

Owing to the European War the work on the canal practically ceased in 1916, and in the fall of 1917 the contracts were cancelled, and the work entirely closed down. After the armistice, November, 1918, the Government decided to resume work on a small scale, and arranged with the former contractors—The Dominion Dredging Co., Section No. 1, Messrs. Baldry, Yerburgh & Hutchinson, Section No. 2; Messrs. Doheny, Quinlan & Robertson, Section No. 3; and the Canadian Dredging Co., Section No. 5, for the resumption of the work, and which has been continued in a more or less intermittent manner, due to labor troubles, and other causes, since January, 1919.

On Section No. 1 the excavation is about 75 per cent completed, and the concrete work 67 per cent. Lock No. 1, including its upper and lower entrance piers, is about 75 per cent built. The concrete built in these structures to date amounts to 178,000 cu. yd.

On Section No. 2 the excavation is about 77 per cent completed, and the concrete work 30 per cent. Lock No. 2, with its upper and lower entrance piers is about 67 per cent built. About 210,000 cu. yd. of concrete have been built in these structures to date. At Lock No. 3 only part of the breast wall has been built.

On Section No. 3 about 60 per cent of the excavation has been taken out, and 5 per cent of the concrete built. Locks 4, 5, 6, 7 and the guard gates are located on this section, but no part of these structures are built, except short sections of the upper entrance piers of Lock No. 6.

On Section No. 5 about 77 per cent of the excavation has been taken out, and wasted between the present and old canals north of Allanburg.

The engineering work is under the direction of W. A. Bowden, M.E.I.C., chief engineer, Department of Railways & Canals, and Alex. J. Grant, M.E.I.C., engineer in charge, at St. Catharines. W. H. Sullivan is principal assistant, and next in authority to Mr. Grant. F. E. Sterns, formerly of the Panama Canal Staff, is in charge of designs. For carrying out the engineering superintendence and construction of the works a field force has been established on each contract, with a resident engineer in charge, who has under him several assistant engineers, instrumentmen, inspectors, etc. The resident engineers on the different contracts are: E. P. Johnson, Section No. 1; F. C. Jewett, Section No. 2; F. S. Lazier, Section No. 3; and H. W. Bruce, assistant engineer, Section No. 5.

Keeping Accident Records in Construction Industry

The keeping of [illegible] records is one of the greatest assistances in preventing accidents and is a fundamental factor in effective safety work. The companies which have been most successful in securing the interest and cooperation of executives, foremen and workmen in accident prevention are practically without exception those which have a satisfactory system of recording statistics and which have devised means for presenting these records in an intelligible form. A further advantage is mentioned in the News Bulletin of the Associated General Contractors, which states that if some plan for keeping accident records could be devised and standardized whereby each contractor could be given an individual rating according to his experience as shown by these records, the proper incentive to decrease accidents and increase safety work would be furnished individual corporations. In other words, when a contractor knew that the more attention he gave to safety propaganda and the more money he spent for safety protection on construction work, the lower his insurance cost would go in proportion to the decrease in his accidents, the more interested would he become in proper safety methods. At the 9th annual congress of the National Safety Council last September, the Construction Section of the council adopted a report which contains much useful information on this subject. The report practically in full follows:

Advantages of Uniform Method of Compiling Accident Statistics. A uniform method of compiling accident statistics should be adopted by all members of the Construction Section. This would enable members to compare their various accident records and let each individual member know how his record compared to others. It would stimulate friendly rivalry between different members to achieve good accident records.

Having the accident records of all members on a common basis would enable the combined experience of all members to be readily analyzed in a scientific manner. Thus, in a very much shorter time than if each depended solely on his individual data, the principal hazards in the whole construction field could be fairly definitely determined. This would make it possible for all to devote their energies to the solution of the most urgent accident problems in the construction field, and to exchange ideas and experiences to the most useful advantage. This would afford a sound basis for concerted action by the membership of the Construction Section as a body in such possible ways, for example, as assisting in the preparation of standard codes, in the bringing of pressure upon manufacturers of construction equipment to induce them to guard their devices at the source; that is, in their shops, etc. It would make it possible for valuable special studies to be made in correlating accident statistics with other phases of construction work, such as endeavoring to determine whether or not any definite relation exists between accidents and such other factors as overtime work, night work, labor turnover, labor unrest, and special types of construction.

Systems for Reporting Accidents. Every accident, large or small, that causes any sort of personal injury, serious or trivial, whether or not it requires any medical expenditure, should be reported and made a matter of record on a printed form provided for that purpose. The reason for this is that in the case of every accident there is a possibility of subsequent complications such as a serious infection. Consequently, it is advisable to have available the essential data relative to the case, such as the name of injured and the time, place, cause and nature of the injury.

There are various satisfactory systems for obtaining a formal report of every accident and any one which is suitable for the individual member should be adopted. Some of the following methods are in use: One method is to have the foreman make out a report of every accident on a prescribed form. One copy of this report is kept on file in field office and one copy is sent to home office. Where there is a medical station or field hospital on the job, a record of every injury is made there. Where there is a safety department on the job, a report of every accident is made by this department. One of the most advantageous methods is to use the standard accident report forms prescribed by the authority administering the compensation law in any particular province or state. Since at the present time almost all the provinces or states have compensation laws and most of them require a report on all accidents, it saves duplication of effort if the forms of the particular state in which the job is located are used for reporting accidents. A certain individual on the job, a clerk, or a first aid man can be designated to see that every accident is reported properly and promptly on the accident blanks. A copy can be kept on file in the job office and a copy can be sent in to the home office.

Form 1 shows a suggestion in the way of a form for use by foremen in reporting accidents and indicates the type of essential facts which should be made a matter of record in the case of every accident.

Standard Definitions for Classes of Accidents.—For statistical purposes the following standard definitions have been adopted:

All accidents, diseases and injuries arising out of the employment and resulting in death, permanent disability, or in the loss of time other than the remainder of the day, shift, or turn on which the injury was incurred should be classified as tabulatable accidents, diseases and injuries. Tabulatable accidents are commonly called "lost time" accidents, although the former term is preferable due to the fact that in the use of the latter term there is danger that the idea might be conveyed that the occasional permanent partial disability with no lost time connected with it is not to be counted. Tabulatable accidents are the only accidents which should be used for comparative or publicity purposes.

Reportable accidents, diseases and injuries include all tabulatable or "lost time" accidents, diseases and injuries and all non tabulatable or "no lost time" accidents, diseases and injuries.

Name. Check No.
Occupation .... ..
Date injured . . . Hour of day. .A.M. P.M. ..
Weather conditions at time of accident ..
Place where accident occurred..... ..
Injured person's immediate superior. .
Where was he at time of accident?...... ...
Had employe been instructed in the work? By whom? .
Machinery, tool or appliance (if any) involved? . . ..
Is it in good condition?...... Was safeguard provided. .
Describe in full how accident happened.. . .
Nature of injury. .. ..
Disposition made of injured...... . . . .
Witness to accident or names of persons with knowledge of accident ....
What can be done to prevent a similar accident? ..
Date.... ...., 19.... Foreman.. ... . . .

Form 1 for Use by Foremen for Reporting Accidents.

Compensable accidents, diseases and injuries as used in any report in accordance with the practice in any particular province or state, should be shown separately and clearly defined.

To the permanent total disability group, should be assigned every accident, disease or injury which is designated by statute as permanent total disability or which permanently incapacitates the workman from performing any work continuously in any gainful occupation.

Permanent partial disability—to this group should be assigned every accident, disease or injury (less than permanent total disability) which results in the loss of, or in the permanent impairment of any function of the body.

Fatal and non-fatal accidents are definitely defined. For statistical purposes, all accidents or injuries are to be considered non-fatal which do not terminate in the death of the injured employe within 28 days of the date on which the injury was sustained. No subsequent correction of the original tabulation is required of non fatal injuries, as thus defined which terminate fatally after more than 28 days of the date on which the injury was sustained.

Days-lost time due to accident should be expressed in terms of working days. Sunday is not to be counted as a working day. Saturday should be counted as a full day, even though only a half day is worked. Calendar days can be converted into working days by multiplying by 6/7.

Unit for Measuring Accidents. The basis of all accident rates is necessarily the number of men exposed to the risk of accidents. It is absolutely necessary to have a common unit for measuring accidents in all occupations, all industries, and all states of countries.

Therefore, it is recommended that all members of the Construction Section adopt the unit of 1,000 hours' exposure or 1,000 workingman hours as the basis for calculating all accident rates. This unit has been adopted by the United States Department of Labor Statistics and endorsed by the International Association of Industrial Accident Boards and Commissions and by many leading members of the National Safety Council.

There are two fundamental kinds of accident rates: Accident Frequency Rates and Accident Severity Rates.

Accident Frequency Rates. An accident frequency rate is an expression stating the number of tabulatable or lost-time accidents occurring in a specified period of time per given number of 1,000 man-hour units of exposure. The accident frequency rate is generally stated as the number of tabulatable or lost-time accidents per hundred 1,000 man-hour units of exposure (per 100,000 man-hours worked) or per thousand 1,000 man-hour units of exposure (per 1,000,000 man-hours worked).

The method of computing follows:

The number of tabulatable or lost-time accidents in any given period are known from the accident reports. The number of man hours worked or hours of exposure during the given period are known from the regular records of any company. Hence the accident frequency rate for the given period is obtained by dividing the number of tabulatable or lost-time accidents by the number of 1,000 man-hour units of exposure. The quotient represents the number of lost-time accidents per 1,000 man-hour unit of exposure or per each 1,000 man-hours worked. The accident frequency rate for the period as stated either as the number of tabulatable or lost-time accidents per 100,000 man-hours worked or per 1,000,000 man-hours worked.

A concrete example to illustrate the method of computing the accident frequency rate is as follows:

The Atlantic Construction Co. in the month of May had occur on their construction jobs a total of 10 tabulatable or lost-time accidents. The total number of man-hours worked on the jobs of the Atlantic Construction Co. during the month of May was 179,880, which is equivalent to 179.88 (1,000 man-hour units of exposure). Therefore, divide 10 by 179.88.

$$\frac{10}{179.88} = 0.056$$

The quotient is 0.056, which represents the number of lost-

TABLE I—SCALE OF TIME LOSSES FOR DEATHS AND PERMANENT DISABILITIES.

Advocated by the International Association of Industrial Accident Boards and Commissions, and by the United States Bureau of Labor Statistics.

Nature of Injury.	Degree of disability in per cent of permanent total disability.	Days lost.
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment	75	4,500
Arm at or below elbow, dismemberment	60	3,600
Hand dismemberment	50	3,000
Thumb, any permanent disability of	10	600
Any one finger, any permanent disability of	5	300
Two fingers, any permanent disability of	12½	750
Three fingers, any permanent disability of	20	1,200
Four fingers, any permanent disability of	30	1,800
Thumb and one finger, any permanent disability of	20	1,200
Thumb and two fingers, any permanent disability of	25	1,500
Thumb and three fingers, any permanent disability of	33 1-3	2,000
Thumb and four fingers, any permanent disability of	40	2,400
Leg, above knee, dismemberment	75	4,500
Leg at or below knee, dismemberment	50	3,000
Foot dismemberment	40	2,400
Great toe or any two or more toes, any permanent disability of	5	300
One toe, other than great toe, any permanent disability of	00	...
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

Notes.

Injuries not involving amputation should be rated as a proportion of the weight assigned to the entire loss of the member involved, in accordance with the degree of impairment.

The weighting for impairment of function of any member should be such percentage of the weighting for dismemberment as may be determined by the adjudicating authority in fixing the compensation for such impairment—i. e., if loss of an arm is compensated by 240 weeks' indemnity, then an impairment of the arm for which 160 weeks' compensation was paid should rate as two-thirds of the loss of the arm in the above scale.

Hernia should be included only as a temporary disability on the basis of the actual time lost.

Jobs or Depts.	No. of Man-Hours Worked.	No. of Tabulatable or Lost Time Accidents							Frequency Rate Accidents per 1,000,000 Man-Hours Worked
		Total	Deaths.	Permanent Total Disabilities.	Permanent Partial Disabilities	Temporary Disabilities			
						Over Two Weeks	Over One to Two Weeks	One Week and Under	
Total									

Form 2—For Compiling Accident Frequency Rates.

time accidents per each 1,000 man hour unit of exposure or per each 1,000 man hours worked. The accident frequency rate of the Atlantic Construction Co. for the month of May is, therefore, stated either as 5.6 tabulatable or lost time accidents per 100,000 man-hours worked or else as 56 tabulatable or lost-time accidents per 1,000 000 man hours worked.

A sample form recommended for use in tabulating accident frequency rate is shown in Form 2.

Accident Severity Rates. The purpose of accident severity rates is to compare the relative seriousness of accidents. The only stable, convenient and satisfactory basis for measuring the relative seriousness of various accidents is by the time lost. An accident severity rate is an attempt to express in a standard, uniform way the economic cost of industrial accidents in terms of time lost. An accident severity rate is an expression stating the number of working days lost per each 1,000 man-hour unit of exposture (or 1,000 man hours worked) due to the tabulatable or lost time accidents occurring in a given period.

The method of computing the accident severity rates is as follows:

The number of working days lost due to the accidents occurring in the given period are known in the case of all temporary disabilities. Furthermore the number of fatalities, permanent total disabilities and also the number and degree of the permanent partial disabilities occurring in the given period are known. In order to derive an expression in the form of a rate the fatalities and permanent disabilities must be taken into account. Therefore, for statistical purposes, to each fatality and permanent disability, must be assigned arbitrary figures representing an equivalent number of days lost. The table of equivalents which is used by the United States Department of Labor Statistics, the International Association of Industrial Accident Boards and Commissions, the National Safety Council, and others, is shown in Table I. The number of days lost due to the temporary disabilities is added to the number of days obtained by taking the equivalents of the fatalities and permanent disabilities and thus the total days lost due to the accidents occurring in the given period are known. The number of man-hours worked or hours of exposure during the given period are known from the regular records of any company.

Hence the accident severity rate for the given period is obtained by dividing the total days lost by the actual number of 1,000 man-hour units of exposure. The quotient represents the number of days lost per each 1,000 man hours worked. This figure is stated as the accident severity rate for the given period.

A concrete example to illustrate the method of computing the accident severity rate is as follows:

The Atlantic Construction Co., as cited above, during the month of May had occur on their construction jobs a total of 10 tabulatable or lost-time accidents; 7 of these 10 accidents were temporary disabilities, one was fatal, one caused permanent total disability and one resulted in the loss of the man's finger, which is a permanent partial disability.

The total number of days lost is determined as follows:

No.	Kind	Days Lost	How Obtained.
7	Temporary disabilities	88	From the actual records of the time lost by the individual injured men supplemented possibly in some cases, where an individual has not returned to work at the time of compiling the record by an estimate as to the time lost by an expert industrial physician.
1	Fatal.	6,000	From Table of Equivalents (See Form 2.)
1	Permanent total disability.	6,000	
1	Permanent partial disability (1 finger lost)	300	
10 accidents		12,388 days lost	

The total number of man hours worked on the jobs of the Atlantic Construction Co. during the month of May was 179,880, which is equivalent to 179.880 (1,000 man-hour units of exposure. Therefore divide 12,388 by 179,880.

$$\frac{12,388}{179,880} = 68.9$$

The quotient is 68.9, which represents the number of days lost per each 1,000 man-hour unit of exposure. Hence, the accident severity rate of the Atlantic Construction Co. for the month of May is stated as 68.9 working days lost per 1,000 man-hours worked.

A sample form recommended for use in tabulating accident severity rates is shown in Form 3.

I. C. C. Redefines Term "Subordinate Railway Official." As a result of information presented at a hearing of the Interstate Commerce Commission on Nov. 1, 1920, by representatives of the American Association of Engineers, including G. W. Hand, assistant to the president of the Chicago & Northwestern Railway and chairman of the Railroad Council of A. A. E., and J. B. Jenkins, valuation engineeer of the Baltimore & Ohio R. R., the Interstate Commerce Commission has redefined the term "subordinate official" as far as it concerns railroad professional engineers. According to regulations issued by the commission on March 23, railroad professional engineers were designated as "engineers of mechanics." This term was not clear as to whether it included mechanical and electrical engineers. The association, therefore, applied for and obtained a hearing. Under the new regulations just issued railroad professional engineers are designated as "technical engineers." This class includes civil, mechanical, electrical and other technical engineers inferior in rank to engineers of maintenance of way, chief engineers and division engineers, engineers of maintenance of way and other technical engineers.

Jobs or Depts.	No. of Man-Hours Worked.	Days Lost Due to							Severity Rate Days Lost per 1,000 Man-Hours Worked.
		Total Days Lost.	Deaths.	Permanent Total Disabilities.	Permanent Partial Disabilities.	Temporary Disabilities.			
						Over Two Weeks.	Over One to Two Weeks.	One Week and Under.	
Total									

Form 3—For Compiling Accident Severity Rates.

Cause and Prevention of Rail Creeping

In a paper by Mr J. A. L. Waddell, Consulting Engineer, presented Nov. [illegible], 1920, before the American Society of Civil Engineers, much information has been collected on a subject of great interest to railway engineers. The creeping of rails has many contributing causes and as yet there seems to be no way of preventing it which will in every case assure success.

As a preliminary to his investigations, Mr Waddell sent a letter, enclosing the following questionnaire, to the federal manager or the president of each of 70 of the principal railroad systems of the United States, Canada, and Mexico, asking for replies to the 16 questions which it contained:

1. What troubles, in your experience, are engendered by the creeping of rails?

2. Is rail creeping proportional to the amount of traffic passing over a track?

3. With the traffic in one direction only, is the creeping greater on down grade or up grade, and to what extent?

4. On a single-track line, is the creeping greater in the direction of the heavy traffic, and, if so, to what extent?

5. On what portions of your line do you find the greatest creeping of rails—on tangents or on curves?

6. Does the degree of curvature affect the amount of creeping?

7. Does one rail in a track ever creep more than the other? Under what conditions?

8. For the same train loads, is the creeping greater on light rails or on heavy ones; and, if so, to what extent?

9. Does the amount of creeping vary with the nature of the roadbed, and with the kind and depth of the ballast; and, if so, to what exent?

10. Does the amount of creeping vary with the temperature and weather conditions?

11. Does the amount of creeping vary with the character and efficiency of the rail splicing; and, if so, to what extent?

12. Does the amount of creeping depend on the use or the non-use of rail-chairs or of tie-plates; and, if so, to what extent?

13. Have you found any satisfactory method of checking or of lessening creeping; and, if so, what is it?

14. Have you evolved any theory as to the cause or causes of rail creeping; and, if so, what is it?

15. Have you had any computations made as to the resultant force causing creeping under specific conditions?

16. Is there any information on the subject that you can furnish, not covered by the preceding questions; and, if so, what?"

The preceding request for information was honored by officials of 49 roads, or 70 per cent of those addressed. In several cases opinions were given by a number of the officials of the system—in one case there were 34 reports from roadmasters; consequently, this paper is really a compendium of knowledge on the subject, furnished by more than one hundred of the best posted men in North America.

Those who answered the questionnaire represented, all told, 190 railroads or railroad systems, covering about 220,000 miles of line, because each federal manager generally had several systems under his control. This total length of line is 50 per cent of the entire mileage of North America.

As was to be expected it developed from the replies to these questions that railroad men are not in complete agreement on the causes of rail creeping or on the ways in which it manifests itself at its worst. As these varying opinions and statements are undoubtedly the result of personal observation and experience, it follows that the causes of rail creeping must vary with a great variety of conditions. As space forbids giving the résumé of answers to each of the sixteen questions as arranged by Mr. Waddell, we can only reproduce herewith his general summary of conclusions which he draws from the evidence submitted:

1. Rail creeping is a matter of serious import not only to railroad men but also to the whole world; for it increases both directly and indirectly the cost of operation and maintenance of every steam railway system, causes great destruction of railroad property and transported goods, and seriously endangers on a large scale the lives of the traveling public.

2. The principal troubles caused by rail creeping are slewing of joint ties and bunching of all ties; distortion of gauge; loosening of joints; pounding down of rail ends; grinding of rail heads and wheel flanges; splitting of joint ties; churning and sliding of ties; splitting and breaking of angle bars, shearing of bolts; cutting of ties and consequent starting of decay therein; loosening, pulling, and shearing of spikes, bunching and squeezing out of ballast; kinking and waving of rails; breakage of track; kicking or buckling of track with consequent derailment; inteference with operation of frogs, switch-points, head-blocks, signals, interlocking, crossings, turn-outs, derails, and other track devices; injury to rolling stock due to rough riding track; and, in, short, the augmenting of all the difficulties known to trackmen.

3. Undoubtedly, the primary cause of the fundamental trouble is traffic; because, when a stretch of track is absolutely idle, there is no creeping on it whatsoever. It is true that other influences, such as temperature changes and weather conditions, aggravate the difficulty; but, alone, they are powerless to cause it. Wave action of rails and ties in front of the passing wheels pushes the rails ahead; and, if these are firmly spiked to the ties, the latter move forward, carrying the ballast with them. Again, the traction of the locomotive drivers and the friction of all braked wheels tend to impart a longitudinal motion to the rails. Long cars and widely spaced axles and trucks augment materially the amount of creeping, as does also unbalanced traffic; but these are unfavorable conditions that may very properly be termed unavoidable. The principal avoidable ones, however, are yielding roadbed, lack of thorough drainage, soft or decaying ties, unequal spacing of ties, badly adjusted super-elevation of outer rails on curves, rails too light for the traffic, inefficient or badly maintained rail-joints, either scant or excessive provision for rail expansion, inadequate or defectively maintained gauge, poor or insufficient ballast, and improper use of train brakes. If the avoidable evils thus listed were effectively corrected, a large proportion of the trouble experienced from creeping track would no longer exist.

4. Rail creeping increases with the amount of traffic, although not necessarily in direct ratio; is greater on down grade than on up grade; on a single-track line is larger in the direction of the preponderance of traffic; in general, is of like amount on tangent and on courve; is often quite different on the opposite rails of a track; is of more serious import on light rails than on heavy ones; is less with firm roadbed than with soft; decreases with improvement in quality of ballast and with augmentation of its depth; varies with changes of temperature; season of year, and weather conditions; is reduced by improving the character of rail-splicing; is not materially affected by the use or non-use of tie-plates; enlarges with the spacing of wheels and trucks; and augments with the speed of trains and with the weights of engines and loaded cars.

5. In respect to the longitudinal forces in track developed by creeping and the horizontal pull between rail-anchors and rails—this is a question to be settled by experiments and not by mathematics. With all due deference to mathematicians in general and to professors of engineering in particular, it can be stated that the question of rail creeping is not one which will properly lend itself to the manipulation of equations based on hypothetical assumptions, because the governing conditions in respect to wave action of rails and track under traffic are far too varied, complicated, and uncertain to warrant any attempt to investigate the subject mathematically. A few valuable experiments have been made to determine the longitudinal thrust of track from creeping, but the results thereof require confirmation by an elaborate series of tests before being accepted as standard or final by railroad men. The inauguration and carrying out of such a series of experiments is naturally the function of the American Railway Engineering Association, which has already done so much to improve the science and art of railway construction in the United States; and the writer hopes that that organization will soon undertake such a series of tests as will settle this question with sufficient accuracy for all practical purposes.

6. In respect to rail-anchors or anti-creepers, these may be divided into two general classes, viz., those which attach to the ties and those which are buried in the ballast. The former type is often effective when the track conditions are first class, but usually fail when they are not, and in that case the second type should be used. To be really effective, however, the latter should extend into the ballast well below the elevation of the bottoms of the ties, because otherwise they would move along with the ballast between the ties, which ballast, of necessity, travels with the track. The writer recognizes that, in some cases, the use of such ballast anchors might

involve questions of electrolysis or of serious import, but believes that these can be satisfactorily solved by proper design, supplemented by experiment. The writer is of the opinion that, in cases of excessive creeping on soft roadbed and ineffectively ballasted track, the best solution of the problem would be the placing of deadmen of either reinforced concrete or creosoted timber in the embankment well below formation level, and connecting both rails thereto by strong, adjustable rods running upward between ties at an angle of about 45 degrees to the vertical. If the creeping tendency is always in one direction, one such rod per anchored rail would suffice; but if it is in both directions, two of them would be necessary. As to how far apart the deadmen should be, that would depend altogether on the tendency of the track to creep. Two or three on each stretch of moving track might first be tried; and if they should prove to be inadequate, more could be added at any time. It is submitted that this method of preventing creeping ought to be much less expensive than making the track truly first class. The details of the suggested anchorage cannot well be evolved before the maximum rail thrust from creeping is determined.

Instead of the suggested deadman, there could be substituted a pair of fairly long 12 by 12-in. creosoted piles, driven just outside the rails, with their tops at the elevation of the base of the rail, and two 8 by 12 or 10 by 12-in. ties laid flat, spiked or bolted tight against them, with several pairs of short blocks or spacers between adjacent ties directly under the rails on each side of the pair of piles. Then, if a type of anti-creeper were evolved, which would grip the rail so effectively that it could not slip through, and if several of these anti-creepers were used for each rail and were attached to the ties, a combination would be effected that would absolutely prevent all creeping, unless the thrust were great enough either to snap off the piles or to tip them out of plumb by compressing the earth and moving the ballast near their tops. It is, of course, possible that the thrust would be great enough to effect one of these results; but, if so, the remedy evidently would be to put in more pairs of piles with their adjacent short spacer blocks.

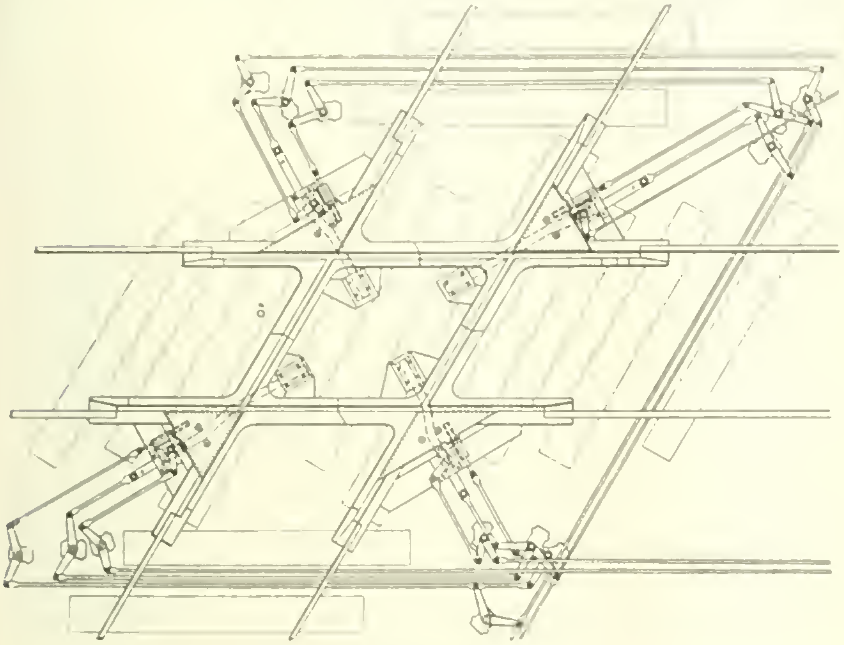
7. In respect to the prevention of rail creeping on important bridges, the writer's practice is to fasten the rails firmly to the deck at the middle of each span and let them slide on tie-plates out to the ends thereof, where a break in the track over each pier is provided.

Am. Soc. C. E. Not to Join Federated Engineering Societies. —The members of the American Society of Civil Engineers in a letter ballot canvassed Nov. 8, voted that the society should not become a member in the Federated American Engineering Societies. In all 5,608 votes were cast, of which 3,278 were against joining. Affirmative majorities were returned from only four districts.

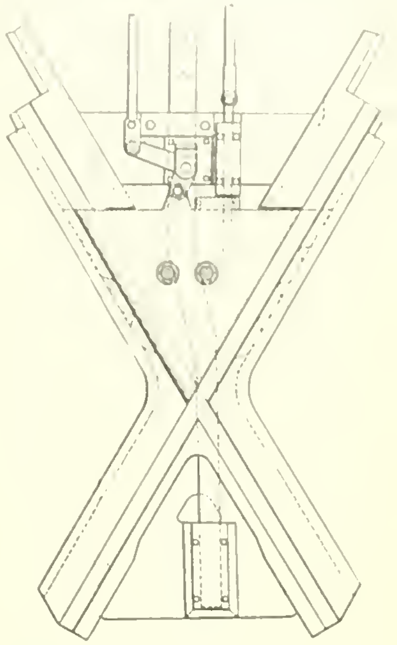
Improvements in the Eymon Continuous Rail Crossing

The above named type of continuous rail crossing, invented in 1908, and since then tried out in service at a number of crossings, has recently been considerably modified in its design, especially with reference to meeting the modern requirements of signals and interlocking.

These modifications have now been carried out with the result that certain advantages have been secured which constitute definite improvements over the original design. The blocks have been made larger so that they now have a length of 28 in. on the running rail edge. They are made of solid manganese steel castings of special composition and are incorporated in manganese steel crossing construction not unlike that now standardized for the regular open flangeway crossings. Another improvement has been to place all the operating rods entirely outside of the diamond of the crossing, so that there are no parts to be caught by dragging brake rigging, etc. Small aperatures have also been introduced in the flangeways of the crossing so that any snow, dirt, etc., is readily cleared out of the flangeway each time that the movable blocks are shifted.



General Plan of an Eymon Crossing as Arranged for Control From Interlocking Tower.



Large Scale View of Movable Block.

Another important feature in the modification has been to place the connections to the operating rods on the under side so that the body of the block is solid and free from any obstructions or openings other than two holes for the bolts by which the bar socket is attached to the block. With these bolts removed, the movable block may be lifted clear for inspection or replacement without disturbing any other part of the structure. The bolts used for this purpose are ordinary track bolts.

Perhaps one of the most important gains resulting from the redesign comes from the facility afforded for making signal connections. Suitable lugs have been provided on the back of the movable block for a connection to a bell crank connected in turn either with mechanical bolt locking or suitable electric locking, as required by accepted standards of signaling. In addition, the arrangement for a plunger lock has been modified so that only one plunger is required, instead of two as in the old design, and this plunger has an eight-inch throw corresponding to standard practice for facing point switches, movable frogs and slip switches, etc.

The illustrations shown herewith are reproduced from the Railway Maintenance Engineer, from which the above notes are also taken.

Toledo, O., Votes for Service at Cost Street Car Plan. At the Nov. 2 election the service at cost franchise for the Toledo Railway & Light Co. was carried by a vote of 45,574 for the franchise and 17,975 against.

Methods of Preventing Stuck Drills

One of the principal troubles that cause difficult drilling is stuck steel. Drill steel becomes stuck for the following reasons Improper alignment of drill steel and hole. Incorrect type of bit Incorrectly formed bits. Feeding too much or too little water. Weak drill rotative power. Worn or broken shanks. Worn or broken drill parts. Drilling into a seam or in fitchery ground. Pebbles falling behind bit or mud collar forming behind bit

The methods that may be used to eliminate these troubles are described as follows by Mr. D. E. Dunn in a recent issue of the Engineering and Mining Journal

A common cause of stuck steel is the improper alignment of the drill steel with the hole. When this occurs the drill steel will bear on at least two points in the drill hole, there is a tendency for the steel to bend, increasing with the divergence from true alignment, and a severe grinding on the reaming surfaces of the bit All of this will cause difficult rotation and will, in many cases, stop rotation entirely.

This condition is due to poor operating. The steel must be brought nearly into line to have it enter the hole. The experienced drill runner can line up the drill laterally "with his eye." He will do this after entering the steel and cranking it nearly to the cutting face, and tighten his "tee-bolt nut" He will then open the throttle (inlet) valve a little, and let the drill find its own vertical line, helping it a little by raising up on the crank end, and finally tightening the clamp bolt nut. If the hole is very much out of line time can often be saved by abandoning it entirely and starting a new one.

Selection of Proper Type of Drill.—The choice of the proper type of bit is important in helping to eliminate stuck steel. For example, a narrow rapid-cutting chisel bit would bury itself in some soft limestones. Six-point bits are usually in disfavor because of their slow drilling and small clearance space for the cuttings.

The cutting edge has the greatest diameter on a single taper bit. This cutting edge wears rapidly, and soon the diameter is less than at another point farther back on the bit. Then the hole cut by the cutting edge is too small to admit the rest of the bit and a reaming action takes place which will soon stall the rotation and stick the steel. To overcome this many and varied designs of bits have been made, some of which were extremely complicated, and if they had any advantage underground, the time taken by the blacksmith to make them and resharpen them more than outweighed this advantage

The bit that has been found most successful for rapid cutting, long-wearing gage, and ease of making and resharpening is the #11 and 15 double-taper cross or four point This double-taper bit when properly made has a reaming surface whose diameter is the same as the diameter of the cutting edge and which backs up the latter with a good stock of metal, increasing the life of the gage. It also acts as a guiding surface, preventing the steel from running off into seams or fissures. The use of this type will, in the majority of cases, remedy any trouble caused by wear of gage.

Methods of Making and Sharpening Drill Steel.—It has already been said that the bit should be properly made. That leads to consideration of the methods of making and sharpening drill steel and their bearing upon stuck steel. Primarily, there are two methods of sharpening drill steel, by hand and by machine. The latter method is by far the more rapid, accurate, and satisfactory, and should be used wherever three or more drills are in operation. However, even machine-made bits are sometimes faulty. This is usually due to careless blacksmithing, because the machines are extremely simple and rugged and, should they get out of adjustment, it is a relatively easy matter to put them into proper condition again

The manufacturers of drill-steel sharpeners are continually making the machines more nearly fool-proof. One of the latest improvements for assuring better bits is the use of double-bored gaging blocks with an adjustable latch guide. The wide range of these blocks permits the operator to gage accurately an entire normal run of steel on the one set of blocks, and these adjustments for the various gages require only the pressure of a finger on the adjustable latch guide.

Some Causes of Stuck Drills and the Remedies.—An interesting but less common cause of stuck steel is the feeding of too much or too little water through the hollow drill steel. When too little water is fed a mud collar frequently forms behind the drill steel, which makes it difficult to extract the latter. Sometimes when drilling into rock bearing metallic ore, and too much water is fed, a mineral separation takes place. The gangue is sludged off, and the drill pounds away ineffectively on the metallic residue, finally becoming stuck. Sometimes dry drills are run in an abrasive ground. The steel soon heats up, and the temper is rapidly burned out of the bit. This condition may be remedied by using a water feed or a wet drill.

Sometimes the shank portion of hexagon steel becomes so worn that it permits the steel to slip in the rotative sleeve, or the lug on round steel becomes worn or broken off, with the same result. The drill steel will then be hammered into the ground without rotating and will soon become stuck. The only remedy for this is to keep the shanks in proper condition. The same results are obtained when use is made of worn or broken drill parts, principally worn pawls, chuck and bushings, and broken pawl springs and rifle bars. The only remedy for this fault is to replace the worn or broken parts.

The rotation of some drills may be too weak for the rock conditions. This, however, is exceptional, because rock-drill manufacturers have strengthened the rotative power of the drills up to a practical limit. Frequently, drill trouble is attributed to weak rotation when that is far from being the true cause.

Unequal cutting may easily take place when drilling into a seam or in fitchery ground, and this throws the steel out of line and sticks it. Drilling into brecciated ground sometimes causes pebbles or small bits of rock to fall behind the bit, and these wedge against the steel and the drill hole, stopping rotation. In some limestones and other calcareous formations the water mixing with the cuttings will form a mud collar back of the bit.

In all of these instances mentioned it becomes a question of loosening and removing the stuck steel. There is one popular method of performing this operation that should not be followed, and that is to pound away on the drill steel with a 16-lb. double jack. This manner of loosening the steel is common, but usually the only real results obtained by it are bent steel, broken drill parts, strong back, and increased vocabulary. Usually the steel itself stays stuck.

Method of Loosening Stuck Drills.—However, there is another method of loosening the stuck steel that is practiced effectively in many camps. Here is how it is worked by Bert Chadwick, mine foreman of the Black Hawk Lead & Zinc Co. at Picher, Okla.

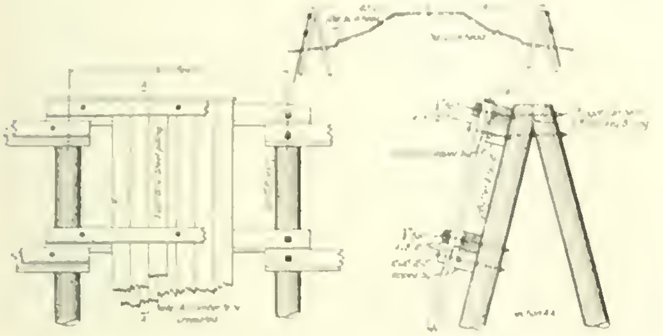
Upon employing a new man he shows him his working place, tells him what he wants done, and then retires to the background to wait for the new man to get into trouble. This the new man usually does, as the rocks are very oppressive and small pebbles continually fall behind the drill bits. Usually in a short time the steel will get stuck in the hole, the drill man begins to sweat, pounds the steel with a sledge, and gets no results. About this time Chadwick steps up, saying, "Let me try it." He takes the oil can, fills the back and front cylinder oil pockets with oil, opens the throttle, and 99 per cent of the time the steel backs out of the hole without any further trouble. The blow slightly loosens the drill steel and the properly lubricated rotative parts take care of the rest.

Lubrication of Drills.—Rock-drill lubrication is not given sufficient thought, yet it is one of the most important items in drill operation. Representatives of the large oil companies and of the large rock-drill manufacturers are waging a continual campaign of education along these lines. Their greatest foes are ignorance, thoughtlessness, and negligence. However, the increased ease of operation and the greater speed of drilling of properly lubricated drills should convince the operator that this matter ought to be properly considered. The increased footage and the decreased cost for drill repair parts should convince the mine manager.

There are proper and improper lubricants for rock drills as for any other machinery. With every drill shipped is sent an "oil tag," which designates the best lubricants for that drill. These tags embody information that has meant exhaustive and costly testing on the part of the drill manufacturers. The information is valuable, and should be recognized as such. However, sad to say, a great number of operators still think that axle grease is good enough, others think cylinder oil will do, and others don't think. Representatives of either oil companies or the rock drill manufacturers are always pleased to consult with the representatives of the mine management and to give them the benefit of expert knowledge and long and varied experience.

Creosoted Timber Bulkhead for Embankment Protection on L. & N. R. R.

A somewhat novel type of bulkhead constructed entirely of creosoted timber and designed to secure the maximum service from the treated material has been constructed by the Louisville & Nashville R. R. for the protection of embankments on its line across arms of the Gulf of Mexico between Mobile and New Orleans. The earlier sheet pile bulkheads had proved rather inadequate for this purpose but the new type, which has been applied to a large part of the exposed embankments in the last few years, has given excellent results. The new design is described in the July Railway Maintenance Engineer to which we are indebted for the matter following:



Details of Bulkhead Used by Louisville & Nashville R. R. on Its Line Across Arms of Gulf of Mexico.

The bulkhead consists of A-frame, two-pile bents spaced 10 ft., center to center, connected on the outer side by two lines of 10-in. by 10-in. stringers to which two-ply, 3-in. vertical sheet piling is secured. The piles of the bents are 30 ft. long and are framed at the top to provide a good bearing and give a horizontal top to the bents. A 2-in. diameter key 8 in. long is inserted in a horizontal groove in the adjacent planes of the two piles to resist vertical displacement of the piles relative to each other.

The stringers are made 12 ft. long to afford lapped joints on the piles, to which they are attached by 1-in. bolts. The sheet piling consists of 3-in. by 10-in. planks 20 ft. long, driven with the stringers as a guide, and the vertical joints of the two layers of sheet piling are offset. This sheeting is held in place against the stringers by 4-in. by 8-in. wales 12 ft. long, laid horizontally on the outside of the piling directly over the stringers, to which they are bolted through the piles by ¾-in. bolts at 5-ft. intervals. As a means of reducing the action of salt water to a minimum, all the boat spikes and bolts are of ingot iron.

Special precautions were taken to protect the top of the piles and sheet piling from sun cracks and the entrance of moisture. The top of each bent of round piles was mopped with hot creosote oil and coated with hot pitch, then covered with a piece of galvanized iron 28 in. wide by 3 ft. 4 in. long, which was bent down around the sides of the piles and held in place by galvanized iron nails. The tops of the sheet piling are similarly protected with a 2-in. by 6-in. timber strip laid directly on the top of the sheet piling.

The piling in the bents was driven by means of a pendulum lead pile driver supported on a platform carried partly on the new bulkhead and partly on the embankment while the sheet piling was driven by a small drop hammer with special leads set to a fixed batter of 3 in. in 12 inclined towards embankment. The finished structure presents a neat and substantial appearance. This form of construction was designed and constructed under the direction of W. H. Courtenay, Chief Engineer, Louisville & Nashville, Louisville, Ky.

Training the Staff of an Electric Railway

Some general principles to be followed in dividing and deputizing executive duties and the application of these principles on the Public Service Railway Co. at Camden, N. J. were given in a paper by Mr. Martin Schreiber, Chief Engineer of the company, read at the annual convention of the American Electric Railway Association at Atlantic City last month. The following abstract is taken from the Electric Railway Journal. We commend it to our readers for its sound common sense and human interest.

The Value of Co-operation.—Before taking up the main line of thought which I wish to lay before the delegates to the Atlantic City convention of the American Electric Railway Association, I wish to tell a story which illustrates the principles to be stated afterward. I live in East Orange, N. J., and to the right and left of me live neighbors each blessed, among other good fortunes, with a fine son of athletic tendencies. My right hand neighbor wished to break his son of over-devotion to athletics and began by assigning for a certain Saturday the task of cutting the grass on the lawn. The purpose of this was to keep him off the baseball field on that day. The boy went to the field and explained the circumstances to his comrades, telling them not to wait for him after a certain hour. The task had been so planned by the father that it was out of the question for the boy to play, and he lost his game. Incidentally the team failed to win the game.

My left hand neighbor tried somewhat the same tactics but with a different result. His son had the job of cleaning up the leaves, but instead of spending the time raking he brought his football team over to the yard and hurried the job through before the game was called. He explained to his father afterward that even if this had not been possible he had arranged for a substitute.

I tell this story because it seems to me that the second boy showed attributes which are necessary in any individual who is to carry executive responsibility. He did the task assigned to him, but he secured the co-operation of others and they were glad to co-operate with him because it was to their interest to do so. Take another illustration, from the experience of E. H. Harriman. When he reorganized the Southern Pacific it was his ambition to build up the greatest of transportation systems. For this purpose he sought out men who had the power of reflection, of initiative and of growth. He had difficulty in locating such a personnel, but afterward said that he could find in the subsidiary offices of the various companies that had been consolidated many men who were human machines but few that were any more. The story is told of him that, when seeking out people for his organization, he would go through the various offices and when he found a man surrounded with books and paper, too busy to notice what was going on, he would not stop, but when he found a man in a reasonably well-conducted office, apparently in thought, perhaps with his feet on the table, he was sure to give that man most serious consideration.

Industry Has Not Developed Ideal Supervising Employe.—Why is it difficult to find the ideal supervising employe? Simply because industry has not developed him. We have spent millions of dollars and much time in developing specifications for material, but little money or time in developing men. Lord Ashfield, or Albert Stanley as we knew him here, is considered one of the biggest transportation men of our time. At fifteen he was working as a switch-boy in the streets of Detroit, at twenty-five he was superintendent of the Detroit United Railway, at twenty-nine he was general superintendent of the Public Service Railway; at thirty-three he was manager and director of the London Underground Lines. Today, Mr. Stanley, barely forty-six years of age, is not only chairman of the board and managing director of the underground lines of London, but is a member of the British House of Lords. In a recent interview published in System, he says that "the secret of how to find big men, who I am sure are growing up to fill the big new jobs of the new century, is opportunity, opportunity, and again opportunity; opportunity must be thrown at them—opportunity to educate and train themselves." From my observation, there are many officials in industry, including those in the electric railway business, who are engaged in suppressing the powers of reflection, or initiative and of growth in employes. Moreover, many officials think that before a man can become an executive, with responsibilities involving several departments, it is necessary for him to have a long specialized training in each department. By applying ordinary arithmetic it can be seen that following this procedure a man would have to be as old as Methuselah before he gets the executive job. By this time he is so old that he has lost all his enthusiasm.

The truth is that when a man has shown ability to excel in handling one department of the electric railway this is a good sign that he could be an executive for several departments. At least he should be in line for such opportunity. It is not necessary to maintain a man in an executive position because he has been tried out in it, but if a company never tries a man out it will never have available competent men to fill the bigger jobs. Some of us seem to forget that we who have been placed in executive positions had, ourselves, to begin at one time.

One of the bugaboos in connection with the railway organization is the securing of teamwork or proper co-ordination. There is much overlap of departments and a tendency for one department to shift responsibility on another. Besides, even where there is loyalty, criticism of the management is often heard. One of the best ways to overcome this difficulty is to insist that the department head take an active part in the management.

On the southern division of the Public Service Railway, at Camden, N. J., we are trying out a new organization plan. Every Friday all department heads gather to lay out the operating policies and work of the railway for the ensuing week. They discuss all questions man fashion. When anything is decided, every member of this "Service Committee," as it is called, is back of the decision and he is responsible for the outcome. The department heads not only carry out instructions given them, but they help to make the orders. This develops the traits that Mr. Harriman was looking for to run his great transportation system.

Responsibility of Department Heads. We also insist that every department head be a "real boss" as far as his department is concerned, and he is strictly responsible for the work coming under his jurisdiction. At the same time he thoroughly understands that as a whole the railway is more important than any one department. Besides, he is expected to break in a man under him to assume his position in case of necessity. His cardinal duties are to do his job as well as he can, to train a subordinate to fill his position and to study for advancement. For example, it is up to the manager to "groom" department heads for the position of manager; to the superintendent of equipment to train an assistant for his job, and so on down the line. The ultimate goal of this committee is to produce the best service we can and to sell it to the public. We want the public to be a willing and pleased purchaser. We hope to have our business relations with our patrons exactly on the same basis as those of the high class department stores with their patrons. In the last analysis the public must be the final judge of what constitutes a satisfactory service.

Passing Service Down the Line. Now the service committee idea is not going to stop at department heads. Each department head is going to inject it into his own department. We believe that this system will produce a different grade of employe from that which we have at present and put a personal touch into transportation business that cannot be had in any other way. For instance, the operating department will be run largely by consultations of the superintendent of transportation, the assistant superintendents, the road officers, the inspectors, the carhouse men and so on. Their meetings will be so arranged that the ordinary routine of business will not be interfered with and all the men that have any supervising work, that is those who have charge of other men, will have an opportunity to take part in these consultations at least once a month. We expect to go further. One of the inspectors on each line will be responsible for that line and he will know its daily receipts and costs. Few facts will be withheld from him and his business will be to make suggestions for improving the service and pleasing the public as well as to his daily routine work. We shall expect this inspector or road officer to consult with other inspectors, if there are any others on the line, and also to discuss the run receipts and costs with the particular crews involved, seeking from them new ideas for bettering the service and pleasing the patrons. In doing this we shall be developing those important qualities that every employe possesses to greater or less degree and that will keep the enthusiasm of the organization keyed up to the highest pitch. Besides we are selling our service first to the employes before we sell it to the public.

The "Rank and File" of the Organization. The attitude of the company and its supervisory officials toward the rank and file is one of the most important problems with which we have had to deal. This body of men today is not what it was even five years ago. The requirements of the men are becoming more and more complex. The other day I saw a poster of the United States Army recruiting service. The poster said: "Get a free education; select any one of six countries; select any one of fourteen branches." Many believe that all the men want is more money; this may appear so on the surface, but I do not believe it. Of course, we should pay a living and a reasonable wage, based on what is being paid in like industries elsewhere, but modified to suit local conditions. Our greatest difficulty lies in the fact that many officials entrusted with the charge of men are unfitted for the job.

I believe that proper negotiations with men must in the final analysis be based on one and only one rule, the Golden Rule or the fair deal. To the employer I would say that you will seldom if ever make a mistake in handling a man if you will make an earnest and conscientious effort to find out all the particulars in his case and then put yourself in his place before you make a decision. If you find a dissatisfied man in your organization, do not turn your back on him. Call him in and endeavor to find out the trouble. Probably a personal matter has discouraged the man; in that case try to make a constructive suggestion. The employe may be dissatisfied with his job. Then it is your duty to try and get him other work, maybe in another department. If he is dissatisfied with his pay try to get him more money. This does not necessarily mean an increase in the rate but it may be possible to place him in different work where he will receive more remuneration. It may be necessary to suggest that he do some overtime work, or work on the outside, or again you may have to send him to one of your friends. Do not be afraid to make it a practice to say to every man leaving the service of the company who has not been dishonorably discharged, "If you ever want to come back, we will be glad to do everything we can to place you," for remember that man, even if he is not an employe of the company, may still be a patron of its lines.

An Officer of Personnel. In connection with the Camden organization, we propose to have one man in our organization who will be in charge of employment. He will hire every man who will be required to run the railway, in no matter what department. Before the employe is passed along for instruction or investigation, this superintendent of employment will interview him.

Many employes are ruined when first they apply for work. The first impression that the new man gets of the company is of great importance. The very fact that he is looking for a job indicates that he is not in the best kind of circumstances, hence a sympathetic attitude on the part of the company officials at that time may reach him and may win his favor and loyalty forever. On the other hand, a too critical attitude on the part of the company's representative, which, I fear, is not unusual, may cut him deeply. He accepts employment because of necessity for work.

It will be the business of our superintendent of employment not only to hire, train and follow the employe from the production standpoint, but it will also be his duty to keep in touch with him from a personal standpoint through his career with the company.

Blasting Pole Holes in Frozen Ground. During the past five or six years a good deal of dynamite has been used for digging post and pole holes in frozen ground. Many contractors, construction foremen and others who have tried it condemn the practice because, they say, it makes too large a hole; that is, too wide at the top and that it has a tendency to loosen the soil too much around the sides of the hole. Inquiry will usually show that the bore holes have been tamped. That is what causes the trouble. To blast a relatively straight up and down, narrow hole and avoid widespread loosening of the sides, the charges should not be tamped in the bore holes, or if tamped at all, it should be very lightly.

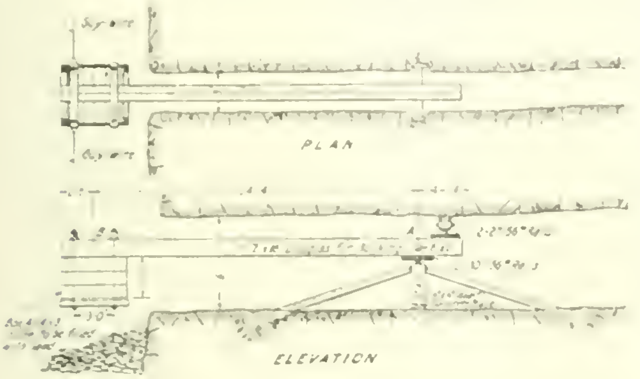
Method of Testing Bearing Capacity of Rock at Dam Site*

By H. J. GAU[illegible]

[illegible] U. S. [illegible]

The site for the Iron Canyon [illegible] the Sacramento River, California, is located in a region where the rock formations are all of volcanic origin. These include tuffs, breccias, agglomerates and basalts. Of these classes the one most suitable for foundations for a dam is the agglomerate and the location of the dam site was governed mainly by the consideration of finding a place in the canyon where this formation is of sufficient thickness under the river to provide a safe foundation. At the site selected the agglomerate lies in a nearly horizontal sheet or bed about 140 ft thick, of which about 110 ft is beneath the river bed.

This rock is composed of volcanic sands, ash, and large and small fragments of lava, mixed and cemented to form a sort of natural concrete of varying hardness. In drilling this material with a core drill few samples were obtained except from the lava blocks, the body of the mass being generally too soft to produce solid cores. There is no stratification or regularity in the formation, the softer parts occurring in irregular masses or pockets. For the purpose of examining this rock more closely a drift or tunnel was excavated into a cliff near the dam site. This tunnel was about 3 by 6 ft. in size and 35 ft in length. It penetrated both hard and soft material, the latter in places being soft enough to be excavated by a pick without blasting.



Plan and Elevation of Testing Apparatus.

Before planning a high masonry dam to rest upon this agglomerate rock it was desirable to know its bearing capacity or supporting power, and to this end a test was made in the tunnel by applying varying degrees of pressure upon an area of 1 sq. ft. on the floor of the tunnel at a point where the softest material was found. The apparatus for making the test consisted of a simple beam or lever 30 ft. long bearing on the roof at one end, with a weight applied at the other. The short arm was 2 ft. and the long arm 24.4 ft. Concrete blocks 12 in. square and 3 or 4 in. in depth were molded on the roof and floor at the points of bearing. The beam was Oregon fir, 14 by 16 in., formed by two pieces 7x16 in. bolted together. The weight used was a wooden box 4 by 4 by 3 ft. inside, filled with sand. Short sections of 56-lb. steel T-rail were used in combination with 12 by 12-in. pine blocks to concentrate the pressure at the proper points on the beam. In the joints between the wood and concrete blocks at the roof and floor steel pointers were inserted, extending out about 3 in. to a vertical graduated scale attached to a frame fastened to posts which were set farther back in the tunnel so as to be unaffected by the application of pressure. By this arrangement a movement of the pointers along the scales would indicate the yielding or compression of the rock.

As a check on the results levels were carefully taken on both roof and floor blocks before and after the test. Five readings were taken on each block and referred to two bench marks before the test and another set of readings at the same points were taken after the test. These level readings showed no measurable settlement or compression at either block. The indicator at the floor block, however, showed a settlement on the scale of 1/[illegible] in. This result was [illegible] for [illegible] [illegible] was [illegible] that the [illegible] [illegible] [illegible] the [illegible] [illegible] readings were [illegible]

[illegible] the [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] beam and empty box	[illegible]	[illegible]	[illegible]	[illegible]
Wooden box partly filled	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] box filled	[illegible]	1[illegible]	[illegible]	[illegible]
[illegible] weight [illegible]	[illegible]	[illegible]	[illegible]	[illegible]

The limit of pressure for the apparatus [illegible] [illegible] tons. What additional pressure the rock would [illegible] supported is not known.

The level readings showed no [illegible] settlement of the floor block as a whole but indicated a slight tilting of the block which was accounted for by the small movement of the beam and post during the process of loading. The conclusion therefore was that there was no measurable yielding at either the roof or floor block.

Applying the result of the test to the design of the dam it is recognized that the conditions are not quite similar for the reason that in the test the load is applied at the top of a pyramid of pressure, whereas under the dam it is applied at the top of a theoretical column of uniform thickness.

Taking into account this difference in conditions since the material stood under nearly 40 tons per square foot without yielding it is considered safe to design the dam with pressure on the foundation not to exceed 10 tons per square foot. All pockets of soft material exposed in preparing the foundations should, however, be excavated so as to leave a surface of the harder rock.

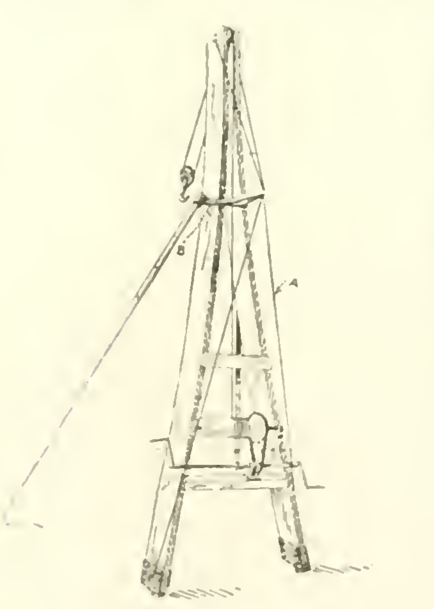
---

*From the Reclamation Record

Home Made Light Derrick for Raising Poles

A light derrick by means of which three men can raise 18 35-ft. poles in half a day is employed by the Molalla Electric Co., Canby, Ore. The device is described by Mr. E. G. Robinson in a recent issue of the Electrical World, from which this note is taken.

The principal details of construction are two 2-in. x 6-in. arms 18 ft. long, forming the frame of the machine. This is braced with No. [illegible] iron wire, which is tightened by eye-bolts as illustrated in the sketch. From the upper end of the derrick is suspended a single-sheave block over which passes a 3/8-in. flexible steel cable used as a hoisting line. This cable is wound on a 6-in. drum mounted near the lower end of the derrick, which is turned by hand through a four-to-one reduction obtained by heavy motorcycle sprockets and chain. Handles may be attached to both ends of the shaft, but it has been found that one man is usually able to raise poles up to 35 ft. in length with ease. When operating, the lower end of the derrick is fastened to the front axle of the automobile by clamps. The rear wheels of the automobile are blocked to prevent movement, giving a very secure anchorage for the derrick. The derrick is braced by two poles similar to pike poles which are inserted in pockets at points some 12 ft. from the lower end.



Details of Light Derrick.

The derrick is transported on a light two-wheeled truck which forms a trailer for the machine. This trailer is hauled by an automobile.

Deep Water Dredges and Notes on Their Design*

By A. W. ROBINSON

The Ladder Dredge. This type of dredge is more largely used in Europe and abroad for general dredging operations, and the detail follows established practice. Only a few examples have been built in the United States. This type is suitable for making wide cuts in open spaces as in approach channels, etc., where there is sea room for setting out the six anchorage lines required. It is also suitable for taking off a thin cut and leaving a smooth level bottom close to grade. A channel cut, 300 to 600 ft. wide, can be made at one time, and the buckets can fill on a cut 3 ft. in thickness.

This type of dredge has been open to the objection of high cost of maintenance, due to wear of the buckets and tumblers, the renewal of which is expensive. This wear can now be minimized by better design, manganese steel pins and bushings, larger bearing surfaces, and renewable face plates for tumblers. For some years the writer has used a packed and lubricated joint for bucket pins and bushings, and grit protected bearings, which have proved a great help. Main driving engines may be direct geared to the tumbler shaft instead of requiring the long transmission formerly used. Side anchorage lines can be carried on spuds submerged to a depth to clear tugs and scows so that there is no trouble from this source. Mooring winches are now frequently arranged for wire ropes carried to a central winch, and the entire dredge is planned for one-man control, so that the large crew formerly needed is reduced to a small number.

The steady speed of running of this type is suited to the economical use of steam expansively by modern marine methods, so that good economy of fuel can be had, and, under good conditions, more cubic yards of material can be raised with this type per ton of coal than any other. It is the only type in which the machinery load is balanced. In the dipper and grab, the work done in lifting the structural parts is lost and in the hydraulic dredge the transport of the water is a loss. The type is more seaworthy than the dipper or grab, as no spuds are used, and the ability to take light cuts over large areas and leave a level bottom close to grade renders it economical for channel deepening in the open or wherever there is sea room to work and set out the anchorages. In European harbor works it is used for general purpose dredging, even in confined locations, and dock cleaning, etc. The writer believes that for such work the dipper or grab would be more suitable, being a self-contained machine standing on its spuds, with no moorings to obstruct navigation. On the other hand, engineers might profitably adopt a modified form of ladder dredge in this country for conditions where it is especially suitable. Ladder dredges have been built in sizes up to 2-cu. yd. capacity of bucket, which, at 14 buckets per minute, is equal to a capacity rate of 28 cu. yd. per minute.

The Dipper Dredge. To those who know the dipper dredge, no introduction is necessary. Built in a variety of forms and sizes, the type ranges from the light and small ⅜-yd. machine suitable for small drainage ditches, to the large and powerful harbor dredge with a 15-yd. dipper capable of working in hard material and deep water. Briefly, the dipper type is suited for general purpose dredging as in harbors, canals and confined spaces where there is not room enough to set out the anchorages of a ladder dredge, and where disposal is by scows or casting on the bank. Having great concentrated power on a large bucket it is better able to handle hard material, boulders, etc., than the ladder type which has less power distributed into a number of small buckets. The dipper dredge is more of a general purpose machine and can cover a wider range of conditions than the other types, which are more of a special nature and suited for their own class of work. It can be adapted to work in mud or soft material equally well, and for this purpose the spuds are fitted with bearing shoes of large area and the dipper is of larger size and without teeth.

No American dredge user would be without this indispensable machine, and as its merits become better known, it is finding its way into all the harbors of the world. As commonly used on the Great Lakes the dipper dredge has been limited to comparatively shallow depth, and is generally of wooden construction, but for deep water and in order to conform to marine practice a different and better class of dredge is necessary.

Among the early dipper dredges of modern type were those designed by the writer in 1886 and thereafter for work on the Great Lakes, which established the type having a single direct wire-rope hoist, bowstring boom, and overhead A-frame. Previous to that time the prevailing type was fitted with a three-chain hoist and crane. These, in turn, have been superseded by later forms with improved detail, until there is now available a machine of the highest marine standard, which is capable of continuous heavy duty and which can be built for depths of 60 ft. and of large capacity and power.

Among the improvements which have been adopted in some of the writer's recent designs are the following:

1. Duplex parallel hoisting ropes, by which smaller ropes can be used over large sheaves for durability.
2. Solid laminated dipper arm, giving much greater strength and resiliency than the usual split arm, and eliminating rack and pinions.
3. Center crank engines for the larger sizes, conforming to marine practice and avoiding overhung cranks.
4. Power feed to the dipper arm as well as brakes, giving better control for maneuvering the dipper and for spotting over scow.
5. Improved type of beam with straight taper and with turn-table built solid with the boom, giving great strength and few parts; center of gravity close to axis of revolution, so that speed of movement is quickly attained.
6. Automatic backing line, in which the slack is taken up automatically and time saved in operating.
7. Improved type of band friction clutch, which does away with all sliding parts or slots in the shaft.
8. Air-operated controls throughout, doing away with mechanical levers.
9. Improved balanced elastic spud mounting for forward spuds by which concentrated stress is safely distributed and heavy loads are safely carried.
10. Improved method of reaving ropes for forward spuds, whereby all sheaves come above deck and the ropes are readily reaved and preserved from injury.

For improved fuel economy in the dipper dredge, much remains to be done. It has not been found advantageous to compound the cylinders of the main engines, as the work is too intermittent and quick responsive action to variable load is essential. For a two-crank engine, the cut-off must be late enough to give good starting power at all crank angles, which means about three-quarter stroke. Three or four-crank engines would give a more uniform torque and good starting power and permit earlier cut-off and consequent economy. Steam can be saved also by reducing the number of steam pipes frequently found on a dipper dredge to the smallest possible number and returning drainage to the boiler. The forward spuds may be worked from the main engines instead of from separate engines. The latter method is favored by some on the ground of saving time in operation, but with the modern quick-acting friction clutch set by compressed air no loss of time occurs, and the condensation of additional engines is avoided. Such engines, being used intermittently, fill up with water between times.

Superheating and condensation will also contribute some benefit, and a three-crank engine for swinging will give a smoother motion and require less steam than a two-crank engine. Attention to all these points, and an ample and efficient boiler will do much to reduce the fuel bill.

The weak points of the prevailing type of dipper dredge are found in the spuds, dipper arm, and boom. As ordinarily used, these parts are a survival of the design first developed in the light and small dredges used on the Great Lakes and in the Middle West where they originated, and which are unsuitable for deep-water and marine service. The difference in conditions is quite comparable to that of a light river steamboat and an ocean-going vessel, no development of the river steamer by making it bigger and heavier would ever fit it for ocean service, and yet this is precisely what has been attempted in several examples of deep-water dredges evolved from lakes and river practice. For instance, one finds plain straight spuds working in plain straight slides of insufficient depth, a split dipper arm of great length and weight with racks and pinions, and a bowstring boom with its weak lower end incapable of resisting twisting.

The question of spuds for deep water is most important.

---

*Abstract of a paper presented Oct. 6 before the American Society of Civil Engineers.

For the early dredges in shallow water a plain straight stick of timber working in plain straight guides answered very well and still answers. The next step was steel spuds of box girder form, but with these the failures have been many. They have not the elasticity of the timber spud, and fail by crushing, buckling, shearing rivets at the points of support and also cause similar action on their supports. The concentrated load on the bottom of the hull is very severe. The middle part of the slide or casing contributes no support and the load is concentrated at the point of contact, causing crushing of the fibers if of wood and shearing of the rivets if of steel.

The logical way to provide for these loads would be first to adopt a spud section that will give the required bending moment with the least weight, and then mount it in such a way that the load at the bottom support is distributed over a sufficient number of rivets to carry it within the limits of good bridge practice. The top support can be mounted in a cage containing multiple springs to obtain elasticity. The writer has developed a spud mounting* on this principle, in which the bottom bearing is formed by balanced shoes of large area, which accommodate themselves to the surging of the spud and in which the stress is received and distributed into the bottom plating of the hull. The spud casing is thus subject to no strain, being clear of the spud altogether, and merely serves to keep out the water. The elasticity provided by the springs at the top is of great value in easing sudden shocks and surging strains, and contributes greatly to the life of the structure. These springs may be M. C. B. standard car springs which are comparatively inexpensive and may be used in any number to provide for the load.

For moving these spuds up and down, wire ropes may be used, and, for large sizes, the ropes may be in multiple. In some designs, notably in the large Panama dredges, these ropes were reaved in a difficult and inaccessible way, with the lower sheave so near the bottom that it got into the mud. In the writer's recent practice these ropes are arranged so that all the sheaves come above deck, and all the reaving and changing of the ropes can be done easily and quickly. Where required for special cases the dredge can be designed so as to be capable of shipping and unshipping its own spuds without the use of a derrick. This is a valuable feature in dredges that go to places remote from a repair yard, and is accomplished by designing the parts so that the spud can be slung up by the main hoist and shipped into place while the boom is swung to the side over the spud.

In dipper arms the usual construction is a split section in order to allow the hoisting rope to pass between. This, although satisfactory for small dredges at shallow depths, is quite unsuitable for heavy work in deep water. Increasing the size and weight, as has been done frequently, only aggravates the difficulty and puts a load on the pinion teeth and shroudings, which is contrary to the most elementary principles of engineering. On this principle the dipper arms on the Panama dredges Paraiso and Cascadas are 12 by 22 in. in section, 72 ft. long, and weigh 40½ tons or, with the dipper, about 60 tons. This huge member is called on to dive and lift and twist and swing while riding on the racks and pinions and being confined in a saddle-block. According to reports, its life is only 6 months and that of a rebuilt arm 3 months, which is not surprising.†

For deep-water work and, indeed, for all work, the writer has discontinued the use of the split form and has developed a solid arm on the laminated principle, composed of wood and steel plates alternately. This combines great strength with resiliency, which is so necessary in working in hard material at great depths. This dipper arm will twist and spring to a considerable extent without injury or deformation. One of these dipper arms has been in service for six years in hard digging and is still practically as good as new. It is light in weight, strong and elastic, has large flat bearing surfaces and plenty of play with no rack and pinions to pinch and wear, and there is no appreciable strain against the saddle-block, as the pinion thrust is absent.

In boom design, the bowstring form is the early wooden boom reproduced in steel and increased in size. It is open to the inherent weakness of a curved lower member to resist the great lateral stress due to the dipper arm when swinging or when swinging is arrested. A long dipper arm constitutes a lever for twisting the boom and splitting it apart. Being confined at the heel, such a boom is invariably weak near its lower end. Attempts to remedy the trouble have been made by greatly increasing the section and weight but without satisfactory results.

To meet this the writer designed some time ago a type of boom which has been used in many dredges and steam shovels with good results. It has a straight taper, is strongest near the lower end, and has wide flange members on bottom to take the lateral thrust of the dipper arm. The turntable is solid with the boom and on deck instead of overhead. This type also possesses two further advantages of fundamental importance. First, it is mounted by its heels on the collar bearing on deck so that it can roll slightly as well as be free vertically, and thus ease the stress due to the side thrust of the dipper arm. This flexibility is a great safeguard when working in deep water. The second advantage is improved visibility of all his work from the operator's stand on the upper deck. It is useful and convenient to have a bridge the whole width of the vessel on the spud framing, and the whole work can be commanded from this point.

These and other improved points of detail enable engineers now to deal with a greater range of work than before without sacrificing any essential advantage and without going to extreme lengths of members. For example, it is now possible to design a dipper dredge that can work in hard material to a depth of 60 ft. that will have a boom 65 ft. long, a digging angle in bottom position of 25°, and an A-frame 48 ft. high. These figures would be impossible to reach with the bowstring type of boom and split dipper arm and they show that depth which covers the requirements of modern deep-draft vessels, with margin for tide, can now be reached effectively.

The Hydraulic Dredge. It is perhaps unnecessary to review at length the hydraulic dredge, the character and type of which are well understood. Briefly, the hydraulic dredge may be divided into four leading types:

1. The sea-going hopper type.
2. The lateral-feeding or ship-channel type, with floating discharge pipe.
3. The forward-feeding or Mississippi type.
4. The radial-feeding type, with spud anchorage.

These four types have been built in a great variety of forms to suit special conditions.

The hydraulic type is sensitive to conditions, and if they are unfavorable or the design not well adapted to them, the output falls off rapidly. On the other hand, for suitable conditions, and disposal considered, it is one of the cheapest methods of dredging—hence the necessity of a careful study of conditions and of making the design to suit.

The principal source of delay and expense in this type is the renewal of worn parts. The wear of pumps and pipes is sometimes severe, especially in cases where high velocity is essential to good output. This wear varies with the kind of material. Thus, sharp sand mixed with stones and clay forms a particularly abrasive combination, while sand alone is less abrasive, and blue clay or mud not at all abrasive. To provide for wear on the interior of pumps, manganese steel linings are frequently used.

Points of recent improvement in hydraulic dredges are as follows:

1. Simpler design of pump with fewer parts, easier to take apart and to replace liners. Pump shells made in two pieces split horizontally. Easy bends and free passages. Adjustable wearing rings to inlet that can be tightened up without stopping pump.
2. Geared turbine drive, occupying less space and weight as compared with reciprocating engine, and permitting the use of a small fast-running pump.
3. More efficient cutter, especially for clay soils.
4. Better steam plant for fuel economy.
5. The use of all steel ball joints instead of rubber sleeves to connect floating pipes.
6. Elastic spring ball joints for pipe lines exposed to sea waves.

These points, and others which might be mentioned, combined with careful design, could not fail to result in marked economy. The geared turbine has now reached a stage which warrants its adoption for this class of work. Although some failures have occurred with reduction gears, both in marine and stationary work, they have been due to preventable causes. Accuracy of toothed surfaces, moderate loads, and perfect lubrication are essential. The great value of

---

*This mounting has been patented.

†Transactions, Am. Soc. C. E., Vol. LXXXII (1918), p. 515.

[illegible] this work is that it permits the design of a pump of small diameter and better protection, and, therefore, it is cheaper and more efficient than a large diameter pump made to suit the slow speed of reciprocating engines. As dredging pumps are from necessity side suction with overhung impeller, this reduction in the weight of the impeller is important as affecting the shaft and bearing.

In the earlier dredges and for free material almost any kind of cutter or agitator would suffice, but this type is now used for more tenacious materials such as clay and hardpan. This is due to the development of an efficient spiral-bladed cutter, of which the cutter designed by the writer for the dredge J. Israel Tarte, in 1901, and the Francis T. Simmons, in 1906, were pioneer examples. When properly proportioned and with the right clearance angles, these cutters excavate the toughest clay cleanly and feed it into the mouth of the suction pipe, so that the pumping part is really only the transporting apparatus to deliver the spoil.

The development of all-steel ball joints for pipe lines is a saving over the rubber sleeves formerly used and permits higher pressures. For moderate pressures a simple ball fitting into a parallel bore socket and self packing with the grit of the material is sufficient. Such a joint is readily coupled and uncoupled. For heavy pressures or long-distance pumping a packed joint may be used. With elastic joints of strong pattern and fitted with spring buffers, dredges can now be worked in waves and exposed locations, which widens the range of work that can be done by this type.

For long-distance pumping it is generally preferable to use relay pumps, limiting each pump to a head of not more than 100 to 120 ft. Pumps can be driven to greater heads than this in single-stage, but the high speed which is no objection in a water pump becomes a difficulty when working with a fluid that carries solid matter. Relay pumps can be suitably driven by electric motor for simplicity, and indeed the entire dredge can be so driven profitably where current is available.

The special feature of the hydraulic type of dredge when a pipe line is used is that it disposes of the material. This operation is costly in power as a large volume of water must be delivered to carry the spoil, and costly also in wear and tear, due to abrasion of pump and pipes. The net result, however, is quie economical as compared with other methods of disposal, and under conditions favorable to large output very low costs can be reached. The percentage of solid matter which can be carried may vary from 5 to 10 in heavy gravel or stones to 50 in soft mud, so that no definite figure can be named.

With regard to the crab or clam shell dredge, this type is well known and does not call for special description. It is exclusively adapted to soft material and finds a wide range of application outside the dredging field, as in handling coal, ore, and sand. As a dredge, it is specially adapted to such work as cleaning out slips, etc., in confined locations, but for hard material or work in the open, the other types are better.

The Motor Bus as a Supplement to Electric Railways

In a paper read before the recent annual convention of the American Electric Railway Association, Mr. R. Gilman Smith, of the Milwaukee Electric Railway & Light Co., gives the results of a comprehensive study of the operating costs of the motor bus with varying densities of traffic. His conclusions are as follows.

That it is economical to utilize the motor bus as a supplement to electric railways only under certain conditions of operation, which may be summarized as follows:

For the operation of extensions to existing car lines or new lines in outlying districts where the traffic density will not run in excess of 1,000 revenue passengers per mile of single track per day and will therefore not be sufficient to support the necessary investment in permanent way, or where the distribution of traffic throughout the day is more nearly uniform. Even such operation may perhaps be economically abandoned if construction costs of permanent way recede from the present high level. For the operation of service over routes where the public will pay an increased fare for what it believes to be a special service and where therefore loading conditions can be somewhat controlled and the small over-normal capacity of the motor bus is not a handicap.

Method of Placing 80 Ft. Through Girder Turntable

An interesting method was recently employed in the removal of a 70 ft. deck girder and placing of an 80-ft. through girder turntable at the Palestine, Tex., roundhouse of the International & Great Northern Ry. As this is the most important engine terminal on this railway, it was imperative that the change be made in the least possible time. The new table was placed in position and ready for operation within 16 hours from the time the old table was taken out of service. The movement of engines into and out of the roundhouse was discontinued but 18 hours.

A brief description of the work and methods used follows:

The first step consisted of the construction of the uew concrete circle wall with pit floor extension, about 5 ft. outside of the old circle wall, maintaining, at the same time, the operation of all radial tracks. Extensions were then made out of rails, well reinforced, which, when fitted to the rails on the old table, would reach and rest upon the new circle wall. The wooden curbing was next removed from the old circle wall. The rails in radial tracks were then cut back and rail extensions placed on the table. The operation of the 70-ft. table was then continued in the 80-ft. pit.

The necessary elevation of the concrete foundation for the center of the new table was nearly 2 ft. higher than the top of the old foundation. A pre-cast, octagonal-shape reinforced concrete block, having a thickness of 2 ft. and a diameter of 5 ft., was made. This block was prepared to provide the additional height required in the center foundation by the new table, and was made with anchor bolts and electric conduit pipe set in place. Four small pipes were also set extending through this block, by means of which drills were later used in drilling down into the old foundation.

In the meantime the old circle wall was broken down by the use of small charges of dynamite and the new circle rail was placed in position. The new table was completely assembled, deck and rails laid, and the table placed, carefully centered, on a flat car. This completed the preliminary preparations for the actual exchange of tables.

The car loaded with the new table was then run onto the old table, which was set at right angles to the direction in which it was intended to remove the old table. By removing the rail extensions on each end of the old table, space was provided for the placing of previously prepared framed bents, and upon these bents the new table was rested. The old table was then turned through a quarter circle, the empty flat car removed and the table quickly taken out of the pit by a locomotive derrick by sliding the table on an inclined skidway.

The old concrete center foundation was then cut down and leveled to the required elevation to receive the pre-cast concrete block. The block was lowered into the pit, slung from the under side of the new table and set in place, melted sulphur being used for a thin grouting. Holes were drilled into the old foundation, steel dowel pins placed and the holes filled with sulphur, thereby securely tieing the block to the old foundation.

As soon as the center castings were in position the new table was lowered into the pit by the locomotive derrick, and was ready for operation.

The work was done by the railway's forces under the personal supervision of F. S. Schwinn, Chief Engineer. R. E. Candle, Division Engineer, directed the work in the field.

Novel Scheme for Repairing Broken Girder Rail

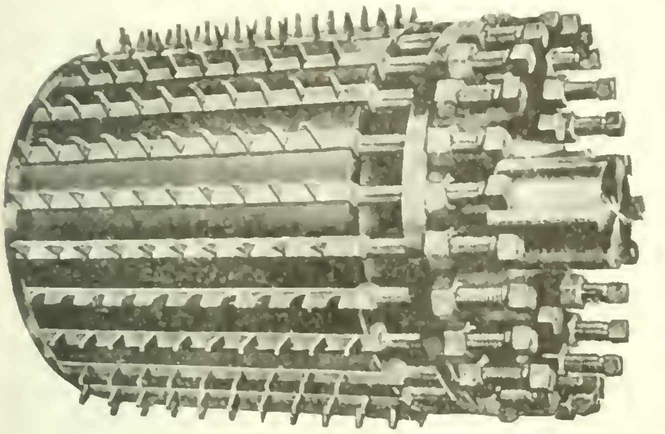
The following description of an unusual method for repairing a break in a girder groove rail in use at New Orleans, is taken from the Electric Railway Journal:

"Either an oxyacetylene flame or a saw is used to cut off a section of the head of the rail at each side of the break. A piece of old center-bearing rail of 9-in. section is then prepared as a "dutchman" splice bar by burning off the base and all of the head except a short piece of about the right length to fill in the gap which has been made between the two broken railheads. Bolt holes are also burned in the web of this piece and it is bolted in place through the web of the running rail and welded at the edges and at the joints in the railhead. Enough metal is deposited along the flangeway, if needed, to make this continuous and [illegible] completes the job by smoothing up both the tread and the flange surfaces of the rail.

If the rail becomes badly cupped at any point or broken down at a joint, thus necessitating the cutting out of a short piece of the rail, such an opening can be [illegible] in and repaired in the above manner. Very good success has been had with rails repaired in this way.

Machine for Perforating Ties Before Treatment

Improved machinery for applying the perforating, or more properly called the incising process, to [illegible] ties before treating them, has recently been designed and built by Greenlee Bros. & Co. of Rockford, Ill., and the Cross Tie Bulletin states that the first machine so constructed has been in service at the St. Helens Creosoting Co., St. Helens, Ore., since Sept. 21, 1920. We reproduce herewith a view of one of the four-toothed rollers in the incising machine and some sections of Douglas fir timber showing effects of penetration, with and without incising.

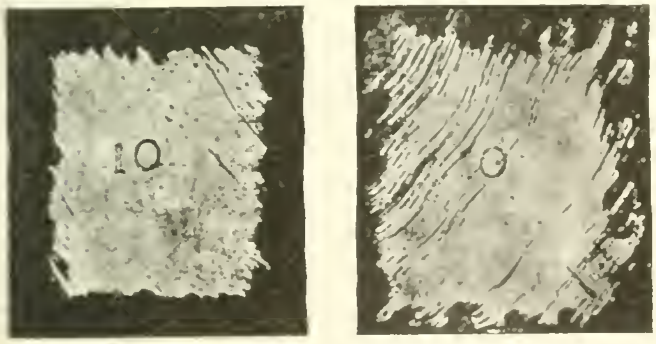


One of the Four-Toothed Rolls of Greenlee Incising Machine.

Quoting from the Cross Tie Bulletin, the summary of the advantages in incising before treatment are as follows:

1. Control, reduction or complete elimination of checking in green ties and timber if perforating is done promptly after cutting. This will be a very important accomplishment, especially in the case of ties to be transported long distances or stored for air seasoning before treatment.

2. Reduction of the temperatures required to secure satisfactory impregnation. This will reduce the injury to the fiber.



Perforated. Not Perforated.

Penetration of Creosote in Perforated and Non-Perforated Pieces of Same Douglas Fir Cross Tie.

3. Reduction of the time required to treat ties and timber in the retorts. This will reduce the loss in mechanical strength.

4. A complete and uniform penetration of the preservative to the depth of the perforations.

5. Reduction of not over 8 to 10 per cent in the strength of the timber in compression perpendicular to the grain. The present loss in the strength and mechanical life of treated unperforated ties or timber varies from 30 to 40 per cent.

Manganese Steel for Track Work

[illegible] information on manganese steel [illegible] was given by Mr. [illegible] Manganese Steel Society and [illegible] in a paper presented Sept. [illegible] Club. An abstract from the paper [illegible].

Manganese steel [illegible] containing [illegible] per cent of manganese, 1 to 1.4 per cent of carbon, not over 0.10 per cent of phosphorus, not over 0.04 per cent of sulphur, 0.2 [illegible] per cent of silica, and the remainder being iron. The [illegible] result is manganese steel [illegible] abrasive [illegible] the combination of strength and ductility. It is [illegible] hard and will not maintain a cutting edge [illegible] tough and cannot be machined commercially at normal temperature except by grinding.

Detroit has been the first [illegible] for the introduction and repeated use of manganese steel in track work to meet severe service conditions. Nowhere in track work has manganese steel proved of such economy as on the turnout switch point which takes the heavy side thrust wear for train movements into the turnout or crossover. Manganese steel gives the greatest efficiency when subjected to wear without pounding, as on a switch point where its life as compared with carbon steel is phenomenal. It is not unusual to get records of 10 to 20 times the life of a carbon rail point.

The track committee of the American Railway Engineering Association, in conference with the standardization committee of the Manganese Track Society and the Manganese Steel Founders Society, has developed plans for many units of special track work. In these designs the first consideration was to provide a manganese steel wearing surface to take all extra shock and wear incidental to carrying wheels across the intersection of the gage lines at the frog point for both facing and trailing train movements. Manganese steel is carried into the throat, and also into the wing flare to take care of wheel flange wear on both sides for wheels entering the frog. The tread surface is provided sufficiently wide to take the wear of badly worn double flanged wheels. Other considerations were the lapping of the manganese steel wearing thread surface with the open hearth rail so that the change from one to the other would not be abrupt, attaching the open hearth rails securely to the manganese casting and to each other for a rigid structure; providing straight lines where possible for economy of machine work and fabrication, distributing metal for strength and sound castings. This is one of the most important, as manganese, in cooling, has a shrinkage about double that of other steels, and the annealing process of quenching from a high heat in water is severe and necessitates careful attention to the correct distribution of metal to avoid excessive internal strains.

A manganese frog properly installed and maintained should give a life approximately equal to that of adjacent open hearth rail. I have records of manganese rail bound frogs maintained in service for 275 millions tons traffic and then being removed on account of the wear on rail arms and adjacent rails rather than wear of the manganese steel. Manganese steel turnout frogs will give better comparative life than crossing frogs, for as the angle increases up to 90 the pound at the intersection increases, which manganese steel cannot so well withstand.

Roughly, it might be stated that 90° manganese steel crossing frogs giving over double the life of O. H. carbon steel are doing well, while as the angle decreases we secure a greater life down to a No. 10 turnout frog, which gives 6 to 10 times greater life than open hearth carbon steel.

Motor Trucks for Expanding Railroad Terminals

An experiment in the use of motor trucks for facilitating interchange of traffic at the railway terminals at Cincinnati, O., has been in progress for about three years and a paper on the working of the scheme was read recently before the Cleveland Engineering Society by Mr. B. F. Fitch, president Motor Terminals Co., New York and Cleveland.

The Big Four R. R. first used the new system, starting operation in May, 1917, between its five main and substations. The original crude installation of open bodies with tarpaulins, moved between these five stations, developed such marked operating economies that its use was recommended for extension to all other contributing lines.

The Motor Terminals Co. developed the equipment and system of operation which was ultimately universally adopted at Cincinnati. Briefly, this system consists of a plurality of interchangeable bodies, or unit containers, one for each movement demand at each station, electrically operated hoists for the lifting and conveying of such bodies, and a limited fleet of motor truck chassis (fifteen in number with one spare) for the transportation of the bodies over city streets between stations.

A recent analysis of accomplishments disclosed the fact that all such freight interchanges have been expedited 52 hours that over 200 cars daily (70,000 annual car days, previously consumed in such service) have been released for main-line movements, that over 300,000 individual switch-cut movements of such cars have been eliminated to the extension of trackage rights for the movement of trains and groups of station cars, that station trackage capacity has been increased 21.4 per cent due to the elimination of trap cars; that station platform area enjoys an increase of approximately 15 per cent, and that total main station realty enjoys an otherwise unobtainable increase of 122,660 sq. ft.

A New Tractor Crane

A tractor crane having several new features has been brought out recently by the Northwest Engineering Works, 28 E. Jackson boulevard, Chicago, Ill. It is claimed that this machine steers as easily as a tractor or motor truck, is at all times under the complete control of a single operator and is thus enabled to enter into distinct lines of work requiring quick action without maneuvering for position or special preparation. The motive and lifting power is furnished by a 60 hp. gasoline motor, mounted on a revolving platform, with a 30-ft. boom and traction unit made up of heavy duty caterpillar treads, operated with shifting gears to provide perfect steerage. The caterpillar traction unit of the machine is so designed that by throwing a lever in the cab, the gear operating the traction on either side may be replaced with a smaller gear and the equipment enabled to make a complete turn in a minimum of time and without disturbing the pavement or material upon which it is running. It is claimed that in this machine the most inflexible features of a gasoline engine drive in dredging or hoisting are overcome, through having the hoisting drums teamed with a brake drum with ratchet teeth, operating against a set of pawls. Thus with the engine operating at a set speed the load can be shifted and dumped at any given point with the same ease that characterizes steam engine efficiency. The balance of hoist upon traction base is stated to be so uniform that the boom can be swung to any angle without the use of jacks, outriggers or stabilizing devices. The flexibility and utilitarian features of the crane were recently demonstrated when it was run up a 25 per cent grade to the top of a coal pile, where it unloaded cars and ran back downward and forward, gradually working up to a higher level as the coal pile expanded. The crawler shoes and sprockets, also two-thirds of the gears used in the crane, are of manganese steel. All high speed gears are machine cut, and are fitted with self-aligning ball bearings. The balance of the gears are helical cut and run in oil tight case.

The Northwest Crawler Crane.

If desired, the crane can be fitted with railroad wheels, clam shell dredge bucket, drag line bucket, pile driver unit, or electric lift magnet.

New Type of Motor Bus

A new type of motor bus put into service recently at Buffalo, N. Y., by the Pierce-Arrow Motor Car Co. is shown in the accompanying illustration. The bus is mounted on a Pierce-Arrow 2-ton dual valve chassis, equipped with pneumatic tires. The steel body is fitted with all the known safety devices and modern conveniences, including electric lights, push buttons, a heating system and window screens and shades. The driver and passengers have clear vision on all sides. The bus is stated to attain a speed of 23 miles an hour with ease, and to handle well in traffic. The bus has a capacity for 25 passengers.

New Motor Bus Recently Placed In Service at Buffalo, N. Y.

Saving Mine Timbers from Decay

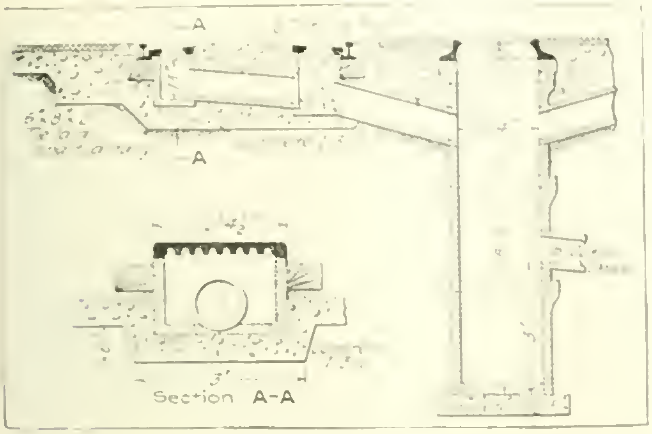
Enormous quantities of valuable timbers are being placed in the coal and metal mines of this country without any preservative treatment against decay. That the life of these timbers might be greatly lengthened by the injection of certain chemicals has been proved by the U. S. Forest Products Laboratory in numerous service tests. In 1910 the laboratory installed in an Alabama mine untreated timbers and timbers which had been treated with coal-tar creosote. Ten years later all the untreated timbers had been removed because of decay, while 80 per cent of the creosoted timbers were still sound and none had decayed to a point where removal was necessary. This is only one of the many records obtained by the laboratory which should induce every mining company to install some sort of wood treating plant.

At least three preservatives have been found suitable for mine work. These are coal-tar creosote, zinc chloride, and sodium fluoride. Creosote is the most effective in preventing decay. Timbers thoroughly impregnated with it are likely to resist decay until they are crushed or worn out. Occasional objection is made to the possible fire hazard of creosoted wood, but long experience indicates that the additional fire risk is very small. Zinc chloride and sodium fluoride are odorless and if anything they tend to reduce the inflammability of wood. They are cheaper than creosote, and although they do not give such permanent protection they greatly increase the life of timbers. Coal-tar creosote may be applied by the brush, dipping, open-tank, or pressure methods. Zinc chloride and sodium fluoride may be injected by the steeping, open-tank, or pressure methods. The cost and effectiveness of the methods of treatment increase in the order given. The saving possible with any of them is so great that it will pay every mine to adopt the use of some preservative on permanently located timbers.

Street Railway Track Drainage

Mr. C. C. Sutherland, assistant Roadways Engineer of Edmonton, Alta., has contributed to the Canadian Engineer an article on the development of track in that city where, as in many Canadian cities the electric railway system is municipally owned and operated.

Track drainage is especially important where large amounts of melting snow have to be taken care of in addition to the ordinary rainfall. The practice in Edmonton is to build drains at least every 500 ft. on a long grade and at the intersection of descending grades. The accompanying illustration reproduced from the above article shows the type of track box in use at present.

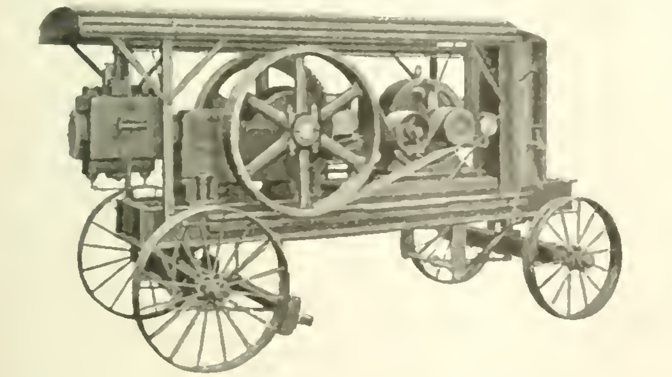


Design of Track Box.

Motor Driven Portable Air Compressor

A portable air compressor driven by electric motor has been brought out recently by the Sullivan Machinery Co., Chicago.

The equipment consists of a standard class WG-6 Sullivan single stage belt driven compressor with inlet valve unloader, as supplied on ordinary stationary units of this type. The compressor and motor run at constant speed, and when the pressure in the receiver exceeds the pre-determined limit, the pilot valve on the side of the air cylinder acts under the impulse of air from the receiver, to raise the inlet valves from their seats, thus allowing the piston to reciprocate without load until the air pressure in the receiver again falls when the pressure on the pilot valve is released, the plungers underneath the air inlet valves drop, thus allowing the valves to seat and compression to be resumed.



Sullivan Motor Driven Portable Air Compressor.

The inlet and discharge valves are of the improved Sullivan wafer pattern, consisting of thin rings of spring steel held in place by curved annular sheet steel springs. This arrangement affords a very short valve travel and a relatively wide port opening, furnishing excellent volumetric efficiency. The air cylinder is cooled by a hopper jacket open at the top and filled from a bucket, thus doing away with water piping and circulating pump. The frame is of the totally enclosed type and the main working parts are oiled by the splash system.

Either direct current or alternating current motors may be supplied as desired and the compressors are furnished in several sizes from 100 up to [illegible] cu. ft. of air per minute to suit customer's requirements.

The outfit, together with the air receiver and electrical apparatus, is mounted on a structural steel frame or truck, the whole being covered by a metal top or canopy with canvas side curtains to protect it from weather.

Public Utility Rates and the Bonus System

Application of the fundamental principles of the bonus system to the rates for the service rendered by a public utility is as logical in its conception as is their application to the pay of a riveter. A riveter of ordinary skill and ordinary health is thought to be worth a definite wage at the start, but if he climbs above the ordinary level by increasing his skill and carefully looking after his health, so that he can work more quickly and energetically, he is rightly entitled to proportionately increased pay. He knows this when he starts the week's work and on pay day his efficiency has been calculated and he receives his pay without argument. His employer is satisfied, for although he has paid more total wages in the period, he has obtained service in full measure and he has made more money.

Few public untilities are rewarded adequately for more than ordinary efficiency, yet what is more reasonable than that a set basis be arrived at upon which they shall receive ordinary returns and that, exceeding this, they shall be rewarded in proportion? At present they do not know with any degree of certainty whether it will be reward or penalty that any twelve-month period will bring. If a highly efficient service is rendered because of the foresight of their managements and skill of their workers, they have no positive knowledge that there will be sufficient revenue to pay the wages that such foresight and skill demand elsewhere. And if they do show such a revenue and something over, experience has shown that more often than not the entire additional pay is returned to their employer—The public. Electric service is a modern institution and its control and regulation must become modern. The utilities and the public are entitled to know in advance what the rewards for efficiency or the penalties for carelessness will be.—Editorial in Electrical World.

Method of Blasting a Wide Ditch

By HARRY GOUGH

Experienced ditch blasters tell us it is not practicable to blast a ditch of a greater width than about 11 ft. The reason is that too much of the material shot into the air falls back into the ditch if it is attempted to cover a greater width than that. While it is true that the greater the width the more dirt will fall back into the cut, it is sometimes possible to blast a ditch considerably wider than 11 ft. Of course, conditions must be favorable.

I recently blasted a ditch 40 ft. wide and 320 ft. long for the New Jersey Cement & Construction Co. at Pomonkey, Md. It was in a swamp. The soil was wet sand and muck.

Following is a description of the method employed. The center line was first laid out. Down the line we ran a row of bore holes 3½ ft. deep and 30 in. apart. Then on a line 3½ ft. on each side of the middle row, two other rows of holes were spaced the same. In each hole we loaded two sticks of 40 per cent ammonia dynamite 1⅛ by 8 size. The three rows were shot together in short sections with electric caps and a blasting machine. The capacity of my machine was 30 holes, but I made it fire 36 holes at a shot on this job; that is, we pulled about 30 lin. ft. per shot. This ditch originally was 13 or 14 ft. wide. Then three more rows of holes were put down on each side of the ditch, loaded and shot as before; that is, nine rows in all, 3½ ft. apart.

Considerable dirt from the two side shots fell into the middle or first cut. In fact, there was quite a bank in the middle. A row of two-cartridge charges were put down in this bank and shot again. This threw out some of the loose dirt, but not by any means all.

Here is where the favorable conditions, making possible a ditch 40 ft. wide and 4 ft. deep, came in. There was con siderable fall and quite a volume of water above the upper end of the ditch. This was dammed up until the ditch was blasted. Then the dam was removed and the flow of water was sufficient in volume and swiftness to carry the loose dirt that had fallen back down to the outlet.

In all, 1,[illegible] lb. of dynamite and 1,[illegible] electric blasting caps were used on the job. They cost $[illegible]. Labor, 96 hours at 60 ct. per hour, amounted to $57.60, making the total cost $49[illegible]. This figures about $1.7[illegible] per running foot, but in that connection it must be kept in mind that the ditch was 40 ft. wide and 4 ft. deep.

Motor Truck Serves as Switch Engine in Breakwater Construction

A motor truck mounted on flanged wheels so as to operate on standard gage railway track is being employed as a switch engine in constructing a breakwater at Santiago, Calif. The breakwater is being built by the W. M. Ledbetter Co., contractors, Los Angeles, Calif., for the purpose of controlling silt deposits from the Santa Ana River. The truck is used to push standard flat cars carrying loads of 80,000 to 90,000 lb. of stone from the railway siding to the derrick on the breakwater, a distance of about 900 ft.

2-Ton White Truck Mounted on Flanged Wheels.

News Letter

St. Louis Items

By A. B. KOENIG.

The Board of Public Service of the city of St. Louis will receive bids until Nov. 26 for improving Natural Bridge Ave. from Union Blvd. to Clara Ave. Plans, specifications, form of contracts and other information can be had at the office of the president, Board of Public Service, room 300, City Hall.

Jansen & Schaefer, Sparland, Ill., expect to finish their work at that point in a couple of weeks. They want another job suitable for a ¾-yd. Erie shovel and about 50 head of stock. Will split outfit if necessary.

P. McGraw, 2232 McCausland Ave., St. Louis, Mo., has an 8-team outfit idle that he wants to place on work in this part of the country.

M. C. Connors of Chicago was with us the other day. Connors is finishing a big sewer job at Bradley, Ill., also some county road work at Brookfield, Mo., and a cut-off for the Burlington R. R. at Nelson, Wis.

Harry J. Carden writes us from Columbus, Mich., that he would like to place a team outfit on some work down south for the winter.

Ira J. Printy has subbed 35,000 yd. of state road work from Cameron, Joyce & Co., near Carterville, Ill.

S. Hannein will finish his work on the Frisco R. R. at Eureka, Mo., the latter part of this month. He is in the market for some more work for his 12-team outfit.

W. Haley came in from L. I. Viall's job on the Frisco R. R. the other day for some labor and supplies. Went back happy.

Robt. Kinkaid will have a 10-team outfit idle at Saratoga, Ark., in a couple of weeks.

Columbus S. Jones, the boss stationman, is laid up at home here with a sore foot. Expects to be out in a few days.

Wm. Henderson, 129 N. Lake St., Aurora, Ill., has a 9-team outfit idle.

W. A. Gierke came in from Waldron, Mo., looking for work for his 9-team outfit which is finishing a levee for the Burlington R. R. at that point this week.

Jack Carroll will complete his levee work at East Cape Girardean in five weeks. When completed, he is going to move his 30 teams on to a new levee job at Gale, Ill.

Contractors when in want of labor or work for their outfits, write Koenig Labor Agency, 612 Walnut St., St. Louis, Mo.; 503 Delaware St., Kansas City, Mo., or 1020 Douglas St., Omaha, Nebr.

O. J. Hanick, 4007 Pine St., St. Louis, Mo., wants to contract for the hauling of 12,000 yd. of gravel near Palmyra, Mo.

Chas. C. Graves, Clarion, Ia., has 15 teams, a fresno and excavator idle. He is anxious to place them on any kind of work in this part of the country.

The contract for constructing a steel bridge over the Osage River, 11 miles east of Jefferson City, Mo., and making a connecting link in the Southern Cross State Highway was awarded to the Kansas City Bridge Co. The steel and piers will cost $125,000. The estimated cost of the entire structure is $171,000.

Commissioner Arthur P. O'Leary reported at the meeting of the East St. Louis Council on Oct. 25 that the improvement of St. Louis Ave., between Collinsville Ave. and N. Tenth St., had been completed at a cost of $53,880. Bids for the improvement of Columbia place were received from the H. H. Hall Construction Co., the Concord Construction Co. and the B. E. Bunnell Construction Co. The bids were referred to the engineering department.

Personals

H. L. Kile, heretofore roadmaster, has been appointed engineer of the Western Division of the Western Pacific Ry.

William B. Bamford, M. Am. Soc. C. E., was elected mayor of Belmar, N. J., at the recent election. He is planning the adoption of the borough-manager type of government which will be the first of its kind in New Jersey.

Dr. William H. Walker has resigned as director of the division of industrial co-operation and research at the Massachusetts Institute of Technology, and will resume his consulting practice. He is succeeded by Prof. Charles L. Norton.

John J. Lamb has been appointed safety engineer at the headquarters office of the National Safety Council, succeeding R. H. Guerrant who, after 2½ years' service, left the council's staff Oct. 1 to take up sales engineering work with the Industrial Appliance Co., of Chicago.

A. T. Dice, Jr., has been appointed assistant superintendent of the Reading and Harrisburg Division of the Philadelphia & Reading Ry. Other changes are: W. D. Kinsey, division engineer, Reading division, to Shamokin division assistant superintendent's offices in Tamaqua; John R. Goodman, division engineer, Harrisburg, to division engineer, Reading; N. W. H. Schaffer, to division engineer, Shamokin; W. R. Dunn, of Philadelphia, to division engineer, Harrisburg.

Chester & Fleming, consulting engineers, Pittsburgh, Pa., having previously announced the retirement of Thos. Fleming, Jr., from and the entrance into the firm of D. E. Davis, J. F. Laboon and J. T. Campbell as partners, now announce a change in the firm name to the J. N. Chester Engineers, and further announce the admittance of E. E. Bankson as a partner. The firm now consists of J. N. Chester, D. E. Davis, J. F. Laboon, J. T. Campbell and E. E. Bankson.

Lewis Nixon, Public Service Commissioner for the First District, New York City, since May 3, 1919, recently tendered his resignation in order to devote his attention to his private business interests. Governor Smith has appointed Alfred M. Barrett, who has acted as Deputy Commissioner since Mr. Nixon's appointment as commissioner. Commissioner Barrett is a former banker, who was connected with several of the principal financial institutions of New York City, and was at one time president of the Guardian Trust Co. Previous to his appointment as deputy by Commissioner Nixon, Mr. Barrett was superintendent of highways of the Borough of Queens.

Industrial Notes

The Austin Machinery Corporation, Chicago, Ill., has established 10 primary district offices and warehouses and upwards of 50 subsidiary offices and agencies throughout the United States. The cities at which the district offices and warehouses are located were selected with a view of affording the most strategic positions from point of trunk-line shipment. Each warehouse carries a full stock of machines and parts.

Blaw-Knox Co., of Blawnox (Pittsburgh), Pa., has established a new sales district in the South, with headquarters in Birmingham, Ala. The Birmingham office is located at 408 American Trust Bldg. In addition, the Blaw-Knox Co. has district offices in New York, Chicago, Detroit, Boston, Baltimore, San Francisco and Sheffield, England. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of the new office.

Fairbanks, Morse & Co. has purchased the entire business consisting of all stock on hand, good-will and liabilities of the Luster Machine Shop & Railway Equipment Co., 917 Arch St., Philadelphia. Fairbanks-Morse have opened a new branch at this address under the management of Mr. D. W. Dunn. The entire personnel of the Luster Machinery Co. has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

Arthur G. Spurlock, on Nov. 1, became treasurer of the H. H. Robertson Co., Pittsburgh, Pa., in charge of finance, accounting, credit, collections, etc. Mr. Spurlock comes from the American Refractories Co., of which he has been treasurer for the past four years. Mr. Joseph Myshrall, who has for so many years fulfilled the duties of secretary and treasurer, will continue as secretary of the H. H. Robertson Co. in charge of corporate records and correspondence, compensation, insurance, contracts, statistics, office management and similar matters.

Albert H. Hopkins has resigned from the presidency of the Engineering Advertisers' Association of Chicago, and from the managership of advertising and sales promotion departments of the C. F. Pease Co., Chicago, to become Chicago manager of the J. Roland Kay Co., International Advertising Agents, at their new building at 161 E. Erie St., just east of N. Michigan Blvd. Mr. Hopkins is well known through the middle west as a former publishers' special representative, and through his activities as an organizer and charter member of the above association. His association with the J. Roland Kay Co. will also be in the capacity of manager of its domestic division.

Clifford F. Messinger has been appointed general sales manager of Chain Belt Co., Milwaukee, Wis., manufacturers of Rex chains, concrete mixers and elevating and conveying machinery, to succeed L. C. Wilson who has resigned to become secretary of the Federal Malleable Co., closely associated with the Chain Belt Co. Other promotions announced are C. E. Stone, assistant to the vice-president, and J. A. Monahan, purchasing agent. Mr. Messinger, for the last two years assistant to the vice-president, has been connected with the Chain Belt Co. since 1911. He is perhaps best known in his capacity as manager of Rex mixer sales, which he held for three years and has also been advertising manager. Recently Mr. Messinger has been elected chairman of a group of nationally known construction machinery manufacturers associated for the purpose of developing export business.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Clamshell Buckets.—Blaw-Knox Co., Pittsburgh, Pa. Two folders, one devoted to the Blaw Bulldog bucket, the other to a discussion of lever arms, S-bends and rated capacities of buckets.

Steam Hoists.—Lidgerwood Mfg. Co., New York. 52-page bulletin illustrating and describing Lidgerwood steam hoists for contractors' uses.

Clamshell Buckets.—G. H. Williams Co., Erie, Pa. 60-page catalog devoted to the Williams Clamshell buckets.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 403 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., NOVEMBER 24, 1920. Number 21.

The Great Defect of Our Present Banking System

When the federal reserve banking bill became a law, one of its greatest merits was supposed to be the creation of an "elastic currency." As a matter of fact this has proved to be its greatest defect.

The legislators who drew the bill, as well as those who voted for it, were deceived by the appearance of financial stability that seemed to be assured through securing a currency that would automatically expand when business is brisk and automatically shrink when business is dull—an "elastic currency." They knew so little of the real mechanism of exchange that they were easily persuaded that a good emergency device would prove equally good when no emergency exists. During the panic of 1907, when nearly all currency ran to a hiding place, it had been seen to be a wise step on the part of banks to create an emergency currency, namely, "clearing house certificates." This emergency currency was illegal, but it served to allay apprehension and entice legal money back into circulation. So it was illogically reasoned that a medicine that had been so effective during an illness should be taken after the illness had ceased; accordingly the Aldrich senate committee recommended a bill in which the medicine of "elastic currency" was prescribed as a part of the daily financial diet.

This was done in face of the almost universal opinion of economists that any change in the volume of money affects a corresponding change in the general level of prices of commodities, unless the change in money is offset by some counteracting change. Among counteracting changes that may occur are changes (1) in the velocity of circulation of money, (2) in the per capita productivity, and (3) in the population, as explained in detail in Mr. Gillette's article in our issue of April 2.

When, due to the increase in per capita money, and the consequent increase in the spending of money, commodity prices begin to rise, merchants and manufacturers begin to stock up with goods in order to take advantage of the unearned increment that they foresee will occur if the rise does not change to a fall in prices. The effect of this is to increase the rapidity with which the existing supply of money must turn over in a year; or, in other words, the velocity of monetary circulation increases. The product of the total money in circulation by the number of times it is turned over annually (or its velocity of circulation) is the total buying power during the year, which may be called the total realized demand for goods and services. Hence we have the simple formula for average prices:

$$p = \frac{M \times V}{N}$$

In which p is the average price, M is the total money, V is the number of times the money is turned over during the year, and N is the total number of units of things and services sold during the year. This factor N, which is the active supply, may be resolved into two factors, namely, total population (P) and per capita productivity (E). Then we have:

$$p = \frac{M \times V}{P \times E}$$

Then, as explained in detail in Mr. Gillette's article of April 2, if the total value of wholesale commodities bears a relatively constant ratio to the grand total value of all retail profits and personal service wages, it follows inevitably that

$$W = k \times \frac{M \times V}{P \times E}$$

In which W is the wholesale index price (or relative average price) of commodities, and k is a constant factor. Mr. Gillette showed that k = 0.5 for the standards of E and V that he uses. The fact that this formula gives results agreeing very closely with the actual wholesale index price for every year, as far back as accurate data are available, establishes its substantial accuracy, and therefore the soundness of the reasoning used in its deduction.

If the formula is correct it shows that the quantity of money (M) is an important factor in determining commodity price levels. Hence it shows that an "elastic currency" that expands when prices rise and contracts when they fall is an elastic evil. Indeed it would be difficult to devise a more effective machine for causing prices to swing up and down rapidly and widely. We have witnessed the efficiency of this machine as a price accelerator, and we are now about to witness its equally damaging efficiency as a price reducer. The price level is now dropping so rapidly that some of the "elastic currency" is beginning to withdraw, and this very withdrawal will accelerate the drop in prices.

Our average wholesale commodity prices are now about 125 per cent above the prewar level, and can therefore decrease another 25 per cent before reaching a level of 70 per cent above the prewar level. When that level has been reached, the factor V (velocity of money circulation) will be back to normal, if the present quantity money (M) remains substantially unaltered. But there is the danger that our "elastic currency" will shrink so rapidly that prices will fall at a rate that will be ruinous to many business men, and therefore produce an ill effect upon all industry.

It is undeniable that a currency that is "elastic" in both directions is preferable to one that is "elastic" in one direction only. The paper money issued by European nations appears to be, for the most part, "elastic" only in the direction of expansion. But is it not feasible to invent a form of currency regulation that will cause the number of dollars in circulation to decrease, instead of increase, as velocity of circulation increases? An ideal currency would be one in which $M \times V \div P$ would be constant. Then the price level would change only as productive efficiency (E) changes. This could be accomplished by retiring some of the currency as the price level rises, which is exactly the converse of what is done under our present federal bank reserve system.

Bankers are naturally anxious to increase their loans where this can be done with safety, but a general and great increase in loans can only be accomplished under our present system by rediscounting commercial paper, and this involves the issuance of more paper currency. Thus it comes about that a banking system designed to secure stability of business really secures stability only in so far as it protects against runs on banks.

Under our present banking system a general collapse of the banks is impossible. But if the system permits recurrent disorganization of all other forms of business, as it certainly does, the present federal reserve law is far from being ideal. The bankers have secured a large measure of security, and in this result every business man rejoices. But surely there is some practical way of stabilizing price levels that will protect the nation from such violent business upheavals as we now witness. On another page will be found an article by Mr. Gillette in which is outlined a method of stabilizing price levels.

A Building-Construction Hazard.—Large, cylindrical columns of concrete are provided, in many factory buildings, for supporting the floors and the loads that are to be imposed on them when the buildings are completed. These columns may be 2 ft. or more in diameter, when finished, and the openings left for them on the floors, before the concrete is poured, are of corresponding diameter. Several men were injured, on a building recently erected, by falling into some of these openings which had been left unguarded. It is plain that a fatal accident might easily result in this way. The prevention of such accidents, states the November Travelers Standard, appears to ba simple matter. A square inclosure, composed of four posts, two sets of rails, and a toe-board, can be erected with little trouble or expense. An inclosure of this kind should be provided for every floor opening, and when the columns have been poured at one floor level the inclosures may be transferred to higher levels, to be used in a similar manner and for the same purpose. All floor openings should be guarded at least as effectively as here described, but in many cases the inclosures should be stronger and of more permanent character, and should be secured so that they cannot be displaced or removed easily. The toe-boards should not be omitted, especially when the conditions are such that persons working at lower levels might be struck by objects falling from above.

Recent Changes in Wholesale Prices

Wholesale prices of commodities reached their peak in May when the index price was 272, as compared with an average of 100 for the year 1913. The corresponding index price for October was 225, a drop of 17.3 per cent in the last five months. For October, 1919, the index price was 223, so that wholesale commodity prices are practically back to the level of a year ago.

The following table, issued by the U. S. Dept. of Labor, gives the index prices for 9 classes or groups of commodities, the index price of each class being 100 for the year 1913:

Group.	1919. October.	1920. September.	1920. October.
Farm products	230	210	182
Food etc.	211	223	204
Cloths and clothing	313	278	257
Fuel and lighting	181	284	282
Metals and metal products	161	192	184
Lumber and building materials	231	318	313
Chemicals and drugs	174	222	216
House-furnishing goods	264	371	371
Miscellaneous	220	239	229
All commodities	223	242	225

The class called Lumber and Building Materials consists of brick, lumber, glass, lime, cement, paint, shingles, tar, putty and rosin. The index price is a weighted average, the "weighting" being proportional to the quantity marketed during the last census year. Any reader interested in the average wholesale prices of each class of building materials for past years, should secure Bulletin No. 226 of the Bureau of Labor Statistics, which gives not only these prices but those of the other classes of commodities for every year from 1890 to 1916 inclusive. Similar data subsequent to 1916 can be found in the Monthly Labor Review, issued by the U. S. Dept. of Labor. There is an excellent government publication called War Industries Board Bulletin No. 1 on Wholesale Prices, 1913 to 1918.

The Prices of Construction Materials

As shown in another editorial, the average wholesale price of building materials in October was 213 per cent above the average for 1913, spite of the fact that the average price of all commodities is now 125 per cent above the average of 1913. It should be remembered, however, that the prices of nearly all building materials are greatly affected by freight rates. In June, 1918, an average increase of 25 per cent occurred in freight rates, but the increase was considerably in excess of this average for building materials. The chairman of the U. S. Senate Committee on Reconstruction and Production, William M. Calder, states that freight rates on building materials were increased 50 per cent on June, 1918.

On Aug. 26, 1920, average freight rates were increased about 35 per cent, and Senator Calder states that freight rates on building materials were increased 40 per cent. An increase of 50 per cent in 1918, followed by an increase of 40 per cent in 1920, is equivalent to an increase of 110 per cent on the original rates.

In the manufacture of brick, cement and lime, the cost of coal is a very big item. Coal is a commodity whose price has risen about 184 per cent since 1913. It takes about a ton of coal to make 1,000 brick, and the Common Brick Manufacturers' Association states the average price paid for coal by members of the association is $10 a ton. The average price of brick sold by members of the association was about $20.38 in September. The U. S. Bureau of Labor, in Bulletin No. 226, gives the average price of common brick in 1913 in Cincinnati at $7 and in New York at $6.56. The following table, issued by the Common Brick Manufacturers' Association, gives average prices in different sections of America, as of Oct. 1, 1920:

Dist. No.	Includes States of	No. of Firms Reporting.	Price per Thousand.
1.	N. Y., Me., N. H., Vt., Mass., Conn., R. I.	10	$24.22
2.	Pa., N. J., Md., D. C.	12	23.43
3.	Va., N. C., S. C., Ga., Fla.	3	21.00
4.	Mich., Ohio W. Va.	9	20.72
5.	Ill., Ind.	16	18.73
6.	Ky., Tenn., Miss., Ala., Ark., La.	16	20.47
7.	N. & S. Dak., Minn., Neb., La., Kan., Mo.	6	16.80
8.	Okla., Tex., N. M.	10	19.50
9.	Mont., Wyo., Ida., Utah, Colo., Nev.	2	20.50
10.	Wash., Ore., Calif., Ariz.	7	18.10
	Total and average	91	$20.38

Existing brick plants are capable of producing six billion brick annually, and the 350 members of the association produce about half the total. The monthly bulletin of the association says:

> Just now there is some talk of a drop in [illegible]. This is the first information that leads to a suggestion that [illegible] can be made cheaper next year. Brick is composed of [illegible] [illegible] and labor. The first item is cheap and plentiful. The [illegible] and supply of the other two plus transportation costs regulate brick prices.

It is evident from consideration of the three controlling items of cost of common brick, namely, labor, coal and transportation, that the price of brick is not likely to decline with great rapidity. It should also be remembered that brick manufacturers seldom carry in stock a very large supply of brick. The Association estimates that its members have on hand about one month's output. In this respect brick manufacturers differ from many others, for they are not under the necessity of selling at less than costs in order to save themselves from bankruptcy. The same doubtless holds true of nearly every class of manufacturer of construction materials, with the possible exception of some of the metals.

In view of the importance of being able to forecast approximately the probable movement in prices of construction materials, we give the following table of wholesale index prices, in which the average for the year 1913 is taken at 100.

TABLE I—WHOLESALE COMMODITY INDEX PRICES. SCALE OF 100 FOR FIVE YEARS 1913

Year	All Commodities	Building Materials	Metals and Metal Products
1840	[illegible]	64	166
1845	[illegible]	[illegible]	117
1850	[illegible]	56	154
1855	96	57	157
1860	90	55	134
61	86	63	133
62	95	87	155
63	110	102	189
64	135	129	265
65	172	106	293
66	144	100	259
67	131	101	210
68	136	101	224
69	122	97	212
1870	117	90	186
71	112	88	177
72	110	97	196
73	108	100	200
74	109	90	184
75	108	84	176
76	104	80	158
77	99	72	141
78	92	68	126
79	87	67	121
1880	93	76	141
81	95	76	130
82	96	80	133
83	94	78	126
84	92	75	111
85	86	74	107
86	86	75	105
87	87	74	105
88	88	73	107
89	89	72	105
1890	84	72	110
91	83	70	101
92	78	67	94
93	78	68	85
94	71	66	72
95	70	65	78
96	67	62	81
97	67	62	72
98	69	65	72
99	75	71	109
1900	82	76	106
01	80	75	98
02	87	77	78
03	84	80	97
04	83	81	89
05	86	85	98
06	91	94	107
07	96	97	121
08	91	92	94
09	94	97	93
1910	97	101	94
11	95	101	90
12	99	94	100
13	100	100	100
14	99	97	88
15	100	94	97
16	123	101	119
17	175	124	208
18	196	150	180
19	211	194	161

Foot Note.—The index prices for 1840 to 1889 are from the Senate Report No. 1394 on "Wholesale Prices," by Nelson W. Aldrich, Mar. 3, 1893. Those for "all commodities" (223 in number) are "weighted" in proportion to family budget expenses, but those for "building materials" and for "metals and metal products" are unweighted or simple averages, and therefore not so reliable, down to 1889.

The index prices from 1890 to 1919 are all "weighted" in proportion to annual consumption and are compiled by the U. S. Bureau of Labor. The Bureau of Labor uses the following materials to derive its weighted average price for "building materials": Common brick, portland cement, [illegible] pine doors, [illegible] window glass, [illegible] Douglas fir, hemlock, maple, [illegible] oak, white pine, yellow pine, [illegible] spruce, paint materials (white lead, linseed oil, turpentine and zinc oxide), putty, [illegible] shingles (cypress, white pine), [illegible] and tar. For the "metals and metal products" [illegible] iron [illegible], cast iron pipe, [illegible] sheets, structural, nails, fence wire, [illegible] copper, [illegible] steel and wire, lead (pig and pipe), [illegible] and sheet, quicksilver, silver, [illegible] knobs, [illegible] locks, planes, [illegible] wood screws.

Book Review

Ordinary Foundations. Vol. I of Engineering and Building Foundations. By Charles Evan Fowler, Consulting Engineer, Member A. S. C. E., [illegible] Eng. Int. [illegible] John Wiley and Sons, Inc., New York. Cloth; [illegible] pp. Illustrated. [illegible]

This book is in reality a fourth edition of the author's work on subaqueous foundations. Enough material has been accumulated to fill three volumes, to be published under the general title of "Engineering and Building Foundations." This treatise retains all the matter on piles, pile driving and ordinary foundations given in the original work. However, the greater part of the book is practically new.

The scope of the work is best illustrated by the chapter titles: I. Historical Development. II. Construction and Practice—Crib Coffer-Dams. III. Construction and Practice—Cribs and Canvas. IV. Pile-Driving and Sheet-Piles. V. Jetting Piles. VI. Construction with Sheet Piles. VII. Construction with Sheet Piles (continued). VIII. Removing Old Piers. IX. Pumping and Dredging. X. The Foundation. XI. The Foundation (continued). XII. Location and Design of Piers. XIII. Location and Design of Piers (continued). XIV. Calculation of Piers, Footings and Retaining Walls. XV. Timber and Timber Preservation. XVI. Retaining Walls and Culverts. XVII. Masonry Abutment Design. XVIII. Design of Pier Masonry.

The author has not limited himself to the dry, ordinary statement of fact. Enough history and personal experiences, good plain advice, and cautions are given to make the book easy and interesting reading.

The data contained in the book are good and up to date in every respect. The book can be considered a standard on the subject.

The text is well illustrated, the cuts being especially clear. Following the eighteen chapters are some selection from specifications, such as for cofferdams and foundations, Ohio River movable dams, steel cofferdams, tests of portland cement and concrete, metal sheet piling, floating pile driver and creosoting piling.

Chamber of Commerce of U. S. to Vote on Improvement of Street Railway Situation.—A referendum vote on proposals for improvement of the situation of the country's street railway lines was asked Nov. 24 of the membership of the Chamber of Commerce of the United States. The recommendations on which the ballot will be cast are advanced by the Chamber's Committee of Public Utilities. They are: 1. Existing traction facilities should be conserved. 2. The attitude now taken toward street railway problems should be based upon the present and future needs of the community. 3. The attitude which is taken toward street railway problems should contemplate private ownership and operation. 4. Regulation should everywhere be instituted that will promptly follow changes in the situation of the companies rendering services of local transportation. 5. Provision should be made against the consequences of unfair competition. 6. All burdens unrelated to the service performed should be removed from street railways. 7. Official responsibility should be definitely fixed for the application of regulation. 8. Each company should seek to have available for the public at all times the facts as to the results of operation and should have resident responsible executives wholly conversant with local requirements.

California Can Now Go Ahead with Road Building.—As a result of the adoption of the highway bond measure at the election Nov. 3, the California State Highway Commission will be in a position to resume its extensive road building program. By providing for a flexible interest rate to meet changing conditions in the bond market, the adoption of the amendment places the Commission in a position to raise money as needed to meet the expenses of the work authorized under the $10,000,000 bond issue of July, 1919.

Determination of Stress-Deformation Relations for Concrete Under Repeated and Continuous Loadings

To the Editor: The writer has furnished a closing discussion to the American Society for Testing Materials, in which he has given consideration to the main points brought out by Mr. Stanton Walker in connection with the latter's discussion of the paper, "Some Determinations of the Stress-deformation Relations for Concrete Under Repeated and Continuous Loadings," as contained in your October 27, 1920, issue. This discussion will appear in due time in the published proceedings of the society, but some of your readers who have read the original paper as well as Mr. Walker's discussion, both published in previous issues, may feel, as does the writer, that Mr. Walker failed to consider the underlying point that the paper intended to bring out, namely, "What is true stress-deformation relation for concrete exposed to continuous and variable loading within the limits of safe design?"

Briefly, Mr. Walker claims that:

1. The stress-deformation relation for concrete is not linear but can only be represented by an equation of the exponential type such as the parabola.
2. The true stress-deformation relation is found at the first application of load after adjusting the compressometer on the test specimen. No consideration is apparently given to the different stress-deformation relation which may be obtained for later applications of load from zero load.

The writer claims from the data of the present investigation as well as previous tests and a study of the large amount of data obtained several years ago by the Technologic Branch of the U. S. Geological Survey at St. Louis, that—

1. With a few exceptions, the stress-deformation relation for concrete, up to and well beyond the allowable working stresses commonly used in reinforced concrete design, is linear for first application of load and may be correctly represented by a straight line.
2. Without exception the apparent parabolic relation, sometimes obtained for first loading, disappears if the load is removed, and the load again applied without further adjustment of the compressometer.
3. The apparent parabolic relation found by Mr. Walker is no doubt partially due to the type of instrument which he employs, i. e., an averaging compressometer with a single dial gage.
4. The type of instrument used by the writer measures the deformation along three elements of the surface evenly spaced about the circumference, and variations in rate of travel of the gage bands furnish warning that load is being unevenly applied. Such unequal rates of loading may sometimes occur when every possible care is taken to properly place and center the test specimen.

From the above it is seen that the disagreement as to the stress-deformation relation reduces to a question of proper testing methods and procedure.

There can be no question concerning the condition of concrete in a structure. As soon as the forms are removed, all concrete members are subjected to variable loads, up to and often exceeding the stresses assumed in design. Therefore, there can be no objection except that of time and cost to determine the stress-deformation relation by repeated applications of load, the consecutive load applications to the maximum to be made with sufficient time intervals intervening. Incidentally it is interesting to note that this interval need be only a few minutes, since immediate reapplication of load results in a curve parallel (same slope) to the previous one with the maximum deformation higher by an amount equal to the residual deformation with the preceding zero load. The same value for the modulus will be obtained from either set of readings.

Whenever the first application of load results in a parabolic stress-deformation, the writer has found without exception that release of all load and reapplication of load to well above unit working loads will result in a straight line relation. For 1:2:4 or richer concretes repeated applications of load may be made up to 50 to 70 per cent of the ultimate strength as determined by crushing specimens of the same shape.

The writer can see no justification for the continuance of a method of testing which does not give proper consideration to the conditions under which a material is used in practice. The generally accepted idea, that the stress is not proportional to the deformation of concrete for working stresses is no doubt due to repetition by most investigators of the common method of taking deformation readings up to that loading which results in a marked increase in deformation, followed by immediate removal of instruments and loading the specimen to failure.

Most text books relating to reinforced concrete construction state that even for working loads the stress-deformation relation is not linear, that the use of the linear distribution in the theory of design is only an assumption, yet investigators in the past have found and called attention to the straight line relation, which the writer has attempted to emphasize. For example, it is stated in Turneaure and Maurer, "Principles of Reinforced Concrete Construction," Second Edition: "After a few additions of load there will be no further set and the stress-strain line will become a straight line up to the load applied," and later, ". . . it was found that under repeated loads not ultimately causing rupture the concrete soon became perfectly elastic. . . ."

In this connection the writer has found that there is no apparent relation between "set" and the straight line relation for stress-deformation. The modulus (slope of line) remains constant or tends to become slightly higher after subjecting a specimen to load of approximately 70 per cent of the ultimate strength for a week or more. (See Figs. 2 and 4 in the Aug. 25, 1920, issue of Engineering and Contracting. In this same article titles and figure numbers for Figs. 1 and 3 have been interchanged.)

The determination of the actual value of the modulus elasticity of concrete for use in design is of no great importance since the figure obtained from tests of small specimens is usually considerably greater for the proportional loads met with in practice than will be calculated from tests of beams. The designing engineer is therefore little concerned with the exact shape of the curve for working loads. In tests of beams loaded to destruction it is necessary that the value of the modulus be known for such extreme loadings, but the determination of such values in no way alters or modifies the straight line relation found for lower loadings.

The main point involved in these discussions is the proper test procedure rather than the determination of an exact figure which will represent the physical property of a material, which has little direct bearing on the design of reinforced concrete. If a straight-line stress-deformation relation is consistently obtained for second and later applications of load, while occasionally first loadings will give a parabolic relation, does it not seem logical that the former is the true relation, especially since the former method of loading is that to which all members of a structure are subjected in practice?

G. M. WILLIAMS,
Professor of Civil Engineering,
University of Saskatchewan.

Saskatoon, Sask.

Are Engineers Irresolute?

About 18 months ago, the movement was started by a group of representatives of engineering societies to introduce a bill reorganizing the Development of the Interior into a Department of Public Works which should look after the engineering activities of the government and co-ordinate them so as to secure efficient planning and construction, and supervision by competent engineers.

This aroused much enthusiasm among all engineers, and was hailed as a first big step toward giving engineering proper recognition of its importance to the public welfare. The National Public Works Department Association was organized and a campaign started to develop public opinion and impress members of Congress favorably to reorganization of government departments so that they would function effectively.

This campaign has been so successful that a general movement has begun in favor of an investigation of all departments with a view to redistributing the work of the government so that all like work will be collected into one place where experts can concentrate on it.

For the first six months after the movement was started, good support was given by the engineers, both in financial aid and in spreading propaganda to create favorable interest.

Their interest began to lag, and for the past six months the N. D. P. W. Association has been carried on by other than engineer financing, while the assistance given by engineers in influencing Congress and the public has been practically nothing. Those who have been working hard on the matter are asking, "Do not the engineers of the country care about public welfare? And do they not appreciate the prestige to be gained by having an entire department devoted to engineering with an engineer at its head as a member of the Cabinet?

In a recent address to the American Institute of Mining Engineers, of which he is president, Herbert Hoover pointed out the need of a national policy on such great matters as development of transportation by rail, highways and waterways; conservation of coal and oil, reforestation and securing control of oil resources outside our borders, development of power and distribution system, including hydroelectric developments and allied water storage systems for irrigation; all problems so big that they are beyond the possibility of private co-ordination, and need the steadying and correlating power of a well thought out national policy.

These things need immediate and continuous attention. They are fundamentally engineering matters and should be considered and controlled by engineers through a department which makes such work its sole and vital business.

The immediate question is one of supporting and influencing opinion rather than of finances. Have engineers started something which they cannot or will not finish? Every engineer can help by writing to his representative in Congress and by using his influence to get others to do the same; also by advocating the passage of resolutions by his association and forwarding them to members of Congress urging the passage of the bill to recast the Department of the Interior into a Department of Public Works.—Editorial in Power Plant Engineering.

Education by Myth and Verbal Subtleties

One of the most distinguished of British scientists, Frederick Soddy, attacked the old-time classical education in a recent number of Nature. He charged that the classical or arts college educates by "myth and verbal subtleties," arguing, as Huxley did before him, that science is slighted for "medieval and drawing-room studies." Continuing, he said that "the traditional education given to the ruling classes trains them to be impervious to new knowledge and able only to find in the old and dead past ideals for imitation and reverence." Science has produced most of our material wealth and has "demolished the cobwebs of traditional economics and finance," giving laws based on fundamentals and truth. According to Professor Soddy, who has had excellent opportunity to observe classical education at Oxford, where he has studied and lectured, much of the world's trouble today from war and industrial discontent is the consequence of the wrong education of the ruling class.

This is a striking indictment of classical education, all the more so because of Professor Soddy's concise way of stating it: "myths and verbal subtleties." He is objecting to the emphasis that arts colleges place upon the vast literature of old customs and traditions, upon seemingly aimless folk-lore, and upon elaborate myths such as those told by Homer and Virgil. Such studies make attractive the circuitous and wasteful methods by which man has drifted from one thing to another, the inexplicable obsessions under which he has labored, the blind ignorance that has made progress so difficult and the obstinacies and loyalties that blend so curiously in human nature. Professor Soddy in speaking of verbal subtleties is objecting to the hair-splitting and the mechanical trifling that have characterized universities since their founding, and that still persist—strange medieval relics in our modern times.

In H. G. Wells' "Outline of History," he points out the development of the pedant among the philosophers of the Alexandrian period, after that Egyptian city ceased to draw men like Euclid, Archimedes and Heron. Says Mr. Wells, speaking of Alexandria's famous museum (or university) as it existed about the time of Christ: "Wisdom passed away from Alexandria and left pedantry behind. For the use of books was substituted the worship of books. Very speedily the learned became a specialized querr class with unpleasant characteristics of its own. The museum had not existed for half a dozen generations before Alexandria was familiar with a new type of human being; shy, eccentric, unpractical, incapable of essentials, strangely fierce upon trivialities of literary detail, as bitterly jealous of the colleague within as of the unlearned without, the bent scholar man. He was as intolerant as a priest, though he had no altar; as obscurantist as a magician, though he had no cave. For him no method of copying was sufficiently tedious and no rare book sufficiently inaccessible. He was a sort of by-product of the intellectual process of mankind. . . . We have still to discover how to preserve our centers of philosophy and research from the caking and darkening accumulations of narrow and dingy-spirited specialists. We have still to insure that a man of learning shall be none the less a man of affairs."

The habit of strange devotion to "trivialities of literary detail," as Mr. Wells puts it, is the fault that Professor Soddy condemns as "verbal subtleties." Hair-splitting of this sort was one of the principal activities of the medieval universities, and undoubtedly, as Professor Soddy says, education of this kind for the ruling class of any country unfits them to appreciate the value of modern science for solving the world's problems.

However, though the arts-educated man is out of date in his thinking and painfully exasperating in his inability to understand the possibilities of the science-educated man, the lessons of the past should not be disparaged so much as Professor Soddy apparently would have us. Education by myth seems the wrong method for young men who must cope with the insistent realities of modern times, but there is much of tolerance and understanding to be gained by an acquaintance with the ancient world. When myths were the only literature of man, the human mind was being impressed in indelible ways that remain unconscious but potent factors in our nature. Habits of thinking that were formed in the childhood of the race determine our decisions today. If, as Kant said, the human mind is like a jelly-mold which transmits our experiences, much of its shaping was done in that prehistoric period when myths were current. It is not a knowledge of myths that is harmful to our ruling classes, but over-emphasis of the purely literary part of the myths and under-emphasis of the history of science in those early times. A study of the historical development of the human intelligence, with suitable stress upon the growth of knowledge in natural science, would teach a ruling class to be open to new knowledge of all kinds. The reading and discussion of man's early struggles with nature from the point of view of modern science would lead students to respect scientific enlightenment as nothing else can. The history of medieval times—when science was so much hindered by superstition and narrow prejudice—if taught to show how science gradually lighted the way in spite of all opposition, would induce college-trained men to give every opportunity to science as an alleviator of man's burden—which is how so distingushed a philosopher as A. J. Balfour regards it.

The proper combination of modern science and the old humanities in education was suggested by the late Sir William Osler, himself a great scientist and classicist. He pointed out that the old philosophers, who are usually studied with no idea of the growth of natural science, were themselves keenly interested in physics, chemistry, mathematics, biology, geology, etc. Aristotle, for instance, was primarily a biologist; Plato was deeply interested and impressed with geometry; the old Hindus mixed up mathematics and mysticism, but were able to grasp the idea of negative numbers before the Greeks did; such a historical personage as Pythagoras was convinced that the science of numbers explains the secrets of nature—an idea to which the atomic theory of chemistry gives some credence today.

The point then is that myths and a general classical grounding are not in themselves bad influences, as perhaps Professor Soddy's address would suggest, but that a study of the ancient world should include the history of science, and should indicate how man's blind fumblings for fundamental truths were cleared up by such scientists as Democritus, Roger Bacon, Copernicus, Galileo, Dalton, etc. The man who has been educated mainly in the conventional studies of the old-time arts college is as narrow as the engineer who knows nothing of the old humanities. As Sir William Osler advocated, the improved education of the future should combine the old and the new, the humanities and the sciences.—Editorial in Chemical and Metallurgical Engineering.

A Suggested Way of Stabilizing Price Levels

By HALBERT P. GILLETTE, Editor

The industrial upheavals that ultimately follow every great war are commonly attributed mainly to the destruction of capital during the war. I am satisfied that this is an erroneous explanation of such post-bellum phenomena. Certainly where the nation is one that emerges from the war with more productive machinery than when it entered the war, it is futile to argue that destruction of its capital accounts for the business troubles that follow the war. Take America, for example. Not only do we have more productive machinery now than in 1914, but we have a better knowledge of how to use it intensively. We have seen, for example, that with 10 per cent of our coal miners enlisted in the army, we were able to produce 10 per cent more coal per annum than we had ever produced before. Our railway system has shown a similar increase in efficiency, although the result was concealed by the greater burden that was placed upon it. Our farmers likewise showed increased ability to meet the demand for food.

All this increase in productivity has occurred, yet we are in the midst of a business depression. But, it will be replied, "Look at the wealth destroyed by war. Look at the labor wasted." Well, what of it? If we had not destroyed it in war we would either have destroyed it in other ways or would not have produced it at all. We still retain not only our original machinery of production, but we have added greatly to it. We have more workers now than ever. Our gold has increased 50 per cent. Our crops are above normal. We must look elsewhere than to the ancient formula, "Capital destroyed" by war accounts for after-war disturbances on business.

As we ponder each of the industrial factors that have changed during the war, not only in America but in every other belligerent country, we can not fail to note one factor that is common to all, namely, an increase in the per capita money. Nor is it probably an inconsequential fact that where the money has increased the most, there the industrial depression is the worst. In Russia a rouble has come to have almost no value. In Germany a mark is worth about one-tenth its one-time value. In France, the price level is 5.2 times what it used to be; in England, 2.7 times; in America, 2.2 times. And in the very same order has the per capita money increased, since 1914, in these nations. Money increase and price increase have gone hand in hand; and then clinging to the coats of both of these has followed a ragged troup of troubles that at least seem to be their progeny.

Whether most of the present industrial troubles are the children of monetary inflation or not, at least some of them are. Every economist will agree to this, and, agreeing thus far, must concede the desirability of stabilizing the prices of commodities. As far as I can learn from rather extensive investigation, there has never been a really serious attempt on the part of any nation to devise a system for stabilizing commodity prices during non-war times. The time has come when this great economic problem should be solved. Accordingly it becomes the duty of all men who have given the subject careful thought to present tentative solutions of the problem. And it becomes the duty of all men to urge upon legislators an early attempt at putting into effect some sort of machinery that will counteract the tendency of price levels to vary rapidly if left unopposed.

There is probably as great economic evil in rapidly rising prices as in rapidly falling prices. It is true that eras of rapidly rising prices are commonly called "good times," but this is because all men are more busy than usual, thus giving an appearance of prosperity which may be illusory. Putting many men at work pumping water from a lake back into the same lake would undoubtedly add to the work done in a nation and the actual business activity, but would not add a pin to the total real income of the people. During "good times" there is a vast deal of pumping water back into the same lake. Production is economically efficient only when it adds to the real income of the people. And real income consists of the things and the service that add to human happiness. But addition to human happiness occurs only through the use of the things and services. Now there is no use derived from producing more food than can be eaten, or from more ships than are needed for water transportation. So whether the thing produced be a thing that must be consumed at once to be enjoyed, or whether it be a thing useful as a tool, the final test of its true worth lies not in itself but in the demand that it serves to satisfy.

Temporary "good times," then, are often bad times in the making. And whether they prove to be bad times depends entirely upon whether the things that are being produced will, or will not, be used later on to satisfy wants.

Bankers naturally feel that they are increasing general efficiency when they are making loans as extensively as is safe. But it is clear that there is an economic limit to such a procedure, entirely aside from the question of safety. Suppose every business man were to find it possible to double his borrowings tomorrow, would he thereby increase the output of useful and usable things? We fail to see how the postponement of the day of settlement (for that is all that credit amounts to) could alter one whit the general output of useful and usable things. Credit can only operate to increase general efficiency of production by weeding out the less efficient managers and giving greater command of production to the more efficient managers. That our credit system effects such a weeding process, at least in a measure, is the sole justification for its existence. All other reasons are sophistical. It follows, therefore, that when the credit system merely enables all the managers to bid equally against one another for things and services, no economic benefit to society results.

To stabilize price levels it is essential to control both the quantity of money and the average velocity with which it circulates. If per capita money increases, prices rise, and this rise leads business men to seek more credit, which results in making money turn over more rapidly. Thus the product of M and V in my formula for wholesale index prices, increases, and prices rise accordingly. (See Engineering and Contracting, Apr. 2, for a long article on the causes of changes in price levels.)

Obviously the government can control the quantity of money (M), and if it could also control the velocity of circulation (V) it would have complete control over price levels. Control over velocity of circulation could be had by regulating the total credits, but this would involve control not only of bank credits (= loans) but of all other credits. Even if impracticable to control credits, it certainly lies within the power of the government to control the quantity of money in circulation (M) in such a manner as to offset fluctuations in the velocity of circulation (V). Prof. Irving Fisher (adopting a plan outlined by A. B. Johnson in 1851) has suggested "stabilizing the dollar" by changing the number of grains of gold in a dollar. Thus when the wholesale commodity index price rises, he would have the government immediately increase the number of grains of gold in the dollar, sufficiently to bring the commodity index price back to its former level.

This, in effect, is a scheme for changing the number of dollars of gold money. Can not the same result be effected quite as readily in another way, and with fewer objections?

A large volume of paper money in excess of the gold back of it is circulated without arousing fears as to its being universally accepted in the country of its origin. Through a flexible system of taxes the government could periodically gather in and retire enough paper money to offset any general rise in prices; and, conversely, could reduce taxes during a falling price level, feed out into circulation more paper money and bring the price level back to normal. A tax on gross incomes could be so graduated as to effect this purpose; nor would it be a large tax, for every dollar of money in circulation actually supports an annual income of about $33, or the money is 3 per cent of the annual income. If the total normal quarterly sales of commodities were, say, $10,000,000,000, and if during a given quarter of a year the commodity index price rose, say, 2 per cent, this would mean sales of $10,200,000,000. Hence to bring the price level back to normal would involve retiring 2 per cent of the money in circulation, and to effect this a tax of 2 per cent of ¼ of 3 per cent, or 0.015 per cent on gross income would suffice. Such a tax as this would not only be exceedingly small at the time of payment, but, in the long run, it would be returned to the public; for if the price-level were to fall below the normal, the paper money collected through previous incomes taxes would be fed back into circulation.

In essence, this plan involves the creation of a governmental reservoir of paper money, which reservoir is automatically lowered when the commodity price level falls, and automatically raised when the price level rises; automatic action being secured by means of a periodic tax on gross income, which tax is determined by the departure of the commodity index price (= price level) from an established standard or normal level.

In practice it probably will be desirable thus to tax only the gross sales of merchants, manufacturers, public utility companies, and mining companies. No injustice would thus occur, not only because every one is a purchaser of the products of those companies, but because the tax itself would merely feed a money reservoir that in turn would feed back into the channels of trade.

How to Handle Treated Timber

Some excellent suggestions on the use of treated timber are given in a committee report submitted at the recent annual meeting of the American Railway Bridge and Building Association. The matter following is abstracted from the report.

The purpose of treating timber is to prevent decay and extend the life of the timber. This result is usually accomplished by impregnating the timber with a preservative of some kind, creosote oil being generally used for bridge timbers and timber used in similar structures.

The efficiency of the treatment is dependent upon and is usually measured by the depth of penetration and the extent to which the untreated portion of the timber is sealed against decay by the treatment. It is obvious that anything done to the treated timber which tends to lessen the thickness of the treated area is abuse and destroys the effect of the treatment to the extent that the treated area is reduced. If the timber is cut or sawed until the untreated timber is exposed decay will be practically as rapid and will do as much damage as if the timber was used without treatment. While it is a recognized fact that it is often necessary to cut or frame treated timber after treatment, much of the framing can and should be done before the timber is treated and whenever it is actually necessary to frame treated timber care should be exercised to see that the work is done in an intelligent manner and with as little damage to the treatment as possible and that hot creosote oil is applied to the cut portion of the timber.

A few examples of the proper treatment of treated material follow:

When treated piles are cut off after driving, the tops of piles should be thoroughly coated with hot creosote oil. It is not enough to paint the tops but oil should be applied as long as the timber will take it.

When boring holes in treated material, holes should be made slightly smaller than the bolts so that a driving fit will be obtained. It is still better to pour hot creosote oil in the holes before driving the bolts.

Where piling is not in proper line after driving, a treated pile should never be adzed to make the bracing fit up, but if the piles are greatly out of line blocks should be applied to the piling to bring the bracing in line. In extreme cases it may be necessary to place lap bracing instead of bracing extending clear across the bent.

The end penetration on a well-treated timber is usually from 3 to 6 in. in depth. Therefore, an inch or so sawed from the end of a well-treated timber will not materially affect the life, but any framing of treated timber that penetrates the area of treatment certainly tends to destroy the effect of the treatment.

The following instructions should be observed in handling creosoted timber:

In unloading creosoted timber care should be taken to see that it does not drop from too great a height to the ground as it has been found in a great many instances that heavy timbers are broken or cracked which is no doubt due to the manner in which it was unloaded. Treated timber is more susceptible to damage from this cause than untreated timber on account of the lessened strength of the timber through treatment.

Creosoted material should not be mistreated with bars, picks, cant or lug hooks in such a way as to make holes extending through the treatment.

In cutting off the piles the tops should be thoroughly covered with hot creosote oil. Better penetration can be obtained by boring holes in the heart of the piling and filling with hot creosote oil. All exposed cut surfaces should be thoroughly covered with hot oil.

In placing sway bracing on bents it is often the practice to cut away piles so that the brace will give more satisfactory bearing. The treated piles should not be cut away to make the bracing fit up, if possible to avoid it, but if piles are greatly out of line blocks should be applied to bring the bracing in line. Where necessary to cut the piling the exposed surfaces should be covered with hot creosote.

Frequently holes are bored in treated timber and left unfilled. These holes should always be plugged with plugs of treated timber.

In general all portions of treated timber which have been cut or bored below the penetration of the creosote should be covered thoroughly with hot creosote oil.

There is no longer any guess work regarding the results which can be obtained through the use of treated timber. Railroad piling, bridge lumber and ties not only have to resist decay but the treatment must be so thorough that it will continue to be effective under severe mechanical wear. Standard practices have been developed that can be relied upon so that, with proper supervision, results of a definite quality may be obtained.

The preservation of wood cannot be accomplished in a casual, off-hand manner. Permanence in service requires the proper penetration of the preservative in the timber treated, and this can be obtained only by the use of proper timber, proper methods, proper preservatives, proper equipment and careful supervision, through all stages of the operation of treatment. It is conceded by all who understand the subject that if one starts with a sound piece of wood, either lumber, piling or cross ties, he can give it a treatment that will protect it from decay beyond its mechanical life; but by no means is every piece of material treated in this manner.

Lumber is composed of two kinds of wood—sap and heart. The sapwood has all the elements of decay within itself and all it needs is the atmospheric conditions to bring the germs of decay to active life. The heartwood is healthy; it has been protected by nature in a manner such that if all outside influences are kept away, it will stay sound for an indefinite period; so in treating a stick, if one absolutely assures that every inch of sapwood is penetrated and the heartwood is surrounded by a treated layer of wood that will not be broken, the problem of preservation has been solved.

Entirely too often the acceptance or rejection of treated timber is based entirely upon penetration, regardless of whether the timber is heartwood or sapwood. When this is done, the purchaser is as apt to accept timber where sapwood only has been treated as he is to reject heartwood with ample treatment to make it last indefinitely. In this connection, the committee would like to emphasize the fact that if the sapwood is thoroughly impregnated the heartwood will last if the treated area is sufficient to compel every bit of moisture that enters the timber to pass through a treated layer of wood and thus be sterilized.

Fireproofing Wood.—A process has been made public in England by which timber is made fireproof, according to Scientific American. It consists in submitting the wood in a closed cylinder to a steaming and vacuum treatment, which removes the air and moisture in the pores of the wood and vaporizes the sap water. The wood is then impregnated under hydraulic pressure with a solution of fire-resisting chemicals, which replace the elements driven out by the preliminary treatment. Finally the water of the solution is dried off, and the chemicals in minute crystal form remain embedded in the fibers. The effect of this treatment is explained as being that on the application of heat the crystals expand and form a glossy coating, which excludes the oxygen of the air and prevents its combination with the wood, thus rendering flame an impossibility. The higher the temperature, the more the crystals expand, and though in time the chemical action of each crystal becomes exhausted and the wood becomes charred fresh crystals come into play, and though the wood may eventually be charred completely through, no flame will be generated. Wood treated in this way does not differ in appearance from wood that has not been treated, and it is claimed that it does not corrode nails or screws.

The Garden City and English Housing Laws

By LEONARD S. SMITH
Professor City Planning and Highway Engineering, University of Wisconsin

The 500 delegates, representing 30 different countries, at the 1920 World Congress on Housing and Town Planning, which gathered at London last June, reached two important conclusions neither of which is yet generally understood by America, viz.:

1. That the furnishing of a decent home to all peoples is the most fundamental question confronting the world today, and

2. That the permanent guarding of these new homes through the adoption of modern town planning principles both in their design and zoning arrangements is of primary importance.

The congress recorded the following specifications as necessary to carry out the above principles:

(a) That in order to secure adequate provision of air and light in and around the homes of the people, there should be definite limitation of the number of dwellings per acre and for space adjacent to dwellings, such limitation being a matter of governmental determination in each country.

(b) That the policy of decentralization of industry and the building of garden cities should be encouraged by legislative provisions and by all other means, both public and private.

(c) That each government, acting in partnership with the local authorties, should prepare in advance and carry into effect, a regional survey, followed by planning schemes, with a view of putting to an end all wasteful and chaotic developments and thus insuring that the lines of future growth shall be well ordered.

(d) That in view of the acknowledged necessity of such action the government, acting in co-operation with the local authorities, shall control the direction and assist in the upkeep of main and arterial roads.

Discussion of Resolutions.—If we should plan future living conditions that will insure to the future a better and more virile human stock (as we are now doing with our animal stock), indeed, even if we are only to insure present standard of manhood and womanhood, we must now set a limit on the further crowding of "sweating of the land" with the new homes we are about to erect. This limit should be set by the local governmental authority and not left to the short-sightedness or greed of the private land owners. We must keep in mind that there is only one crop of land and that its use must be husbanded, instead of exploited and wasted. In spite of the overwhelming importance of this fact, it is only within very recent years that any attention has been given such matters, especially in the United States. At last it has become very clear that any real and lasting progress in housing our people must proceed along two lines, (a) the decentralization of industry and (b) the constant use of modern town-planning principles, the application of which in all cases shall depend upon adequate and authoritative information of the local facts securable only by complete regional surveys. Piece-meal city planning has always proved a most wasteful and unsatisfactory way of expending either private or public funds. The enormous social and economic waste caused by the war must now compel all countries to adopt scientific methods of conserving time, energy and material.

The excessive centralization of industry in our cities and the resulting phenomenal growth and crowding of city population is the most potent and remarkable fact of the past century. In the United States more than half the population now lives in cities while at the beginning of the century the proportion was less than 10 per cent. In Europe the proportion of urban population is even greater and in England is quite 80 per cent. This constantly increasing urban population originates and continually accentuates the great inter-related problems of housing and transportation. Our streets were never laid out or intended for so dense a population, where a single block today may house as many as the entire city of 50 years ago.

Temporary relief has been sought by expensive arcading or widening of our streets, and in extreme cases by the construction of entirely new streets through closely built-up districts, while in the largest cities traffic congestion has compelled the building of hideous elevated street railroads or even the construction of costly underground tubes.

The Garden City Remedy.—None of these attempts have met the situation; in fact, in many cases they seem to have only made a bad matter worse. The world is now ready for a real remedy and fortunately it is at hand, the garden city. The London Congress has given its official sanction to the garden city as the most certain and economic method of decentralizing industry and permanently preventing bad housing, and traffic congestion, while at the same time largely reducing the high cost of living. Fortunately this statements rests upon the secure basis of actual accomplishment as illustrated in the garden cities of Letchworth, Bourneville and scores of less famous examples. But since the oldest garden city is now scarcely 20 years old, a word of description may help American readers to realize its social and economic significance. A suitable tract of agricultural land located on one or more railroad lines, not distant more than about 20 to 30 miles from some large city, is purchased at its agricultural value and a city is laid out on modern city planning lines for a definite maximum population. Materials are purchased in train-load lots and thousands of houses, of a most substantial and pleasing architecture, are erected out of funds provided by the sale of both bonds and stock. As a rule, two-thirds of the entire city area are permanently reserved for allotment gardens, forests, parks, playgrounds and open spaces. Each house is provided with a lot of at least 3,600 sq. ft. with a front yard, used chiefly as a flower garden, and a back garden for vegetables. The latter have been so intensively cultivated as to produce on the average an amount equal to half of the yearly rent.

Houses in the Garden City of Bourneville.

The agricultural belt is chosen so as to surround the city proper, insuring to the inhabitants all the advantages of both city and country.

Before the houses are finished, industrial companies, harassed by the inadequate supply and the unsatisfactory quality of labor found in the large city, are glad to remove their plants to sites provided by the garden city where they will have the additional advantages of reliable and well-housed labor, low taxes and plenty of room for needed expanion. For example, over 50 industrial companies—some of them being branches of American firms—have already established themselves at the garden city of Letchworth* about 35 miles from London. The industrial section of such a city is located adjacent to the railroads and on the leeward side of the city to prevent smoke troubles, while the workmen's homes are located within easy walking distance of the factories.

The improved labor and living conditions insured by such a system has been found to result in remarkably lowering of child as well as of adult mortality. At Bourneville and Letchworth, for example, child mortality is only 40 per thousand of births as compared with 120 per thousand, the average of England, or 100 per thousand, the average of United States. Moreover, accurate statistics show that the garden city boy of Bourneville is several inches taller and weighs several pounds more than the boys of same age born and brought up in the slums of Birmingham, only 7 miles distant.

---

*This city now has a population of 8,000.

It is well established that child welfare statistics form the most sensitive and accurate index of housing and living conditions. The human flower, indeed, refuses to grow and bloom normally under crowded conditions which provide filth and immorality instead of sunlight and sanitation.

Comparison of Life in Large City and in Garden City.—The following comparison of the life of a workman in a metropolitan city and in a garden city like Letchworth accurately sketches the picture with reference to the other members of the family—father and mother.

LIFE IN LARGE CITY.	LIFE IN GARDEN CITY.
1 Noise and rush waste of nervous energy.	1 Natural, vigorous and healthy life. Conservation of nervous energy.
2 Two or three hours traveling under distasteful conditions with fares to pay.	2. Thirty minutes' walking a day under pleasant condition including that for mid-day meal at home. No fares.
3 Meals away from home, costly and inconvenient and not like "mother's."	3. All meals at home with the family.
4. Plenty of dust and dirt and little air and sunshine for wife and kiddies.	4. Little dust and dirt and plenty of air and sunshine at home—and in the factories.
5. Suburban dullness, or slum squalor, tenements	5 Ideal city, no slums
6. No agriculture.	6. Organic contact with agriculture by gardens.
7. An hour away from real country and then a struggle for a bus	7. Always within easy walking distance of real country.
8. Large taxes and small lots	8. Smaller taxes and larger lots.
9 Building and land cost high.	9 Building and land cost low.
10. Vegetables old and high in cost.	10. Vegetables fresh from worker's own garden.
11. Death and sickness rate high.	11 Low death and sickness rate.
12 Education expensive because of high child death and sickness rate. No room for recreation around schoolhouses.	12. Education cheaper and more efficient. Plenty of play grounds. Better home influences.
13. Local government complex and poor because of poor citizenship.	13. Local government simple and well ordered. Good citizenship.

By no means does this list exhaust the advantages secured to the family in a garden city. It is high time that all peoples recognize the fact that there is a limit to reasonable and economic growth of cities. Many cities are already too large for the social and physical good of their citizens as well as too large and complex for the economic production and transportation of manufactures.

Rather than attempt the costly and radical replanning of their street systems as well as the additional means of transportation required for a larger and more crowded city population, a solution to these great city problems should be sought in the planning and building of numerous satellite or garden cities. Such cities will not only take care of future expansion of industry and population, but may also even serve to decentralize present city crowding. Both results are imperatively needed. Moreover, successful examples of such garden cities can be cited both in Europe and in America so that their practicability is fully established.

The establishment of garden suburbs at the immediate city limits is not to be commended. Such suburbs only temporarily improve metropolitan conditions and ultimately must push the country further away from the city, besides adding their population to the already overburdened transit facilities of the city.

Democracy has no greater handicap than the evil conditions that mar our greater cities. These conditions are closely connected with bad and inadequate housing of the working man. Enlightenment, public spirit and the larger life never flourish in mean and inhuman surroundings. If such conditions must be endured in the many century-old cities of Europe, no such excuse can be given for their creation and tolerance in our American cities, few of which are even 100 years old.

May we not look forward to the speedy construction of many more beautiful, self-contained and self supporting garden cities in our own progressive America!

English Housing Subsidies.

Present Housing Conditions.—The effect of the war has been:

(1) To increase abnormally the shortage of houses;

(2) To suspend practically all work of closing and repairing unfit houses and the clearing of slums;

(3) To increase the cost of labor and building materials to about three times pre-war prices;

(4) To increase the interest on capital; and

(5) To produce an acute shortage of building materials.

Even in the years preceding the war there had accumulated a distressing housing shortage all over Great Britain. But the war, by adding enormously to city growth and by the practical stopping of house construction, created a house famine truly alarming. A royal commission appointed in 1919 reported that the housing shortage was an important cause of the labor and social unrest. This shortage in England and Wales alone amounted to quite 500,000 houses. It was early realized that the private builder could not be relied upon to make good this deficiency, especially in view of the certainty that the high cost of labor and building materials, current during and at the close of the war, could not last perman[illegible]and, in fact, that a shrinkage of 25 per cent or mo[illegible]s an assured thing.

Park at Garden City of Bournville.

Government Subsidies.—Under such circumstances the [illegible]nglish government has shouldered the load and responsibility of assisting the building of homes, regarding such expenditures as an inevitable consequence of the war similar to the paying of bounties and pensions to its soldiers. As early as July, 1917, the war cabinet decided that substantial financial assistance would be given "to those local authorities who are prepared to carry through without delay, at the conclusion of the war, a program for the housing of the working classes." It was appreciated that these classes would be unable to pay an economic rent based on the abnormal cost of houses and accordingly the state offered to bear three-quarters of any loss in rent for a period of not less than seven years, and also a similar proportion of any loss in the inventoried value of the houses at the expiration of such 7-year period. The local government was to bear the remaining one-quarter except in case this should add more than "1 penny in the pound to the resulting taxes" (about 0.4 of 1 per cent; i. e., 4 mills). At the same time the state offered to loan government funds for house building at the current rates of interest. Of course all offers of state aid were for limited periods only and under regulations of control of size and architectural features.

The British Institute of Architects instituted competitions for different styles of houses suitable for the various districts, having in mind local requirements and local supply of building materials. It is also interesting to note that in these plans of new cottages, regard must be had to the convenience and comfort of the housewife, especially in the interior arrangements, and that the best way to secure this was to consult with the housewives themselves. A women's committee was accordingly appointed by the Ministry of Reconstruction and rendered important services.

Public Utility Companies. The federal authorities early realized that the complete solution of the housing problem is not likely to be accomplished except with the co-operation of private enterprises, including public utility societies. The latter is defined as a society (with limited liability) registered under the Industrial Act of 1893 for carrying on any industry, business or trades specified in or authorized by its rules. The law provided also that (1) the society must provide for an audit and publication of its accounts. (2) Must limit interest and dividend to 6 per cent per annum. (3) The provision of working class houses must be specified as one of its objects.

There is no statutory definition of "the working classes" which is applicable to housing, but the government circulars state that this term "should be generously interpreted."

Sources of Help.—A public utility society can obtain assistance from two sources, viz., the federal government and by the local authority of its area, county, town or district council.

The government is helping in two ways: (1) By loans of money. (2) By money subsidies.

Recent laws provide that the state loan commissioners have power to loan sums not exceeding three-quarters of the purchase price of the land together with the cost of its development and the buildings erected thereon provided the department is satisfied with the security. The terms of the mortgage given for the loan provide for the repayment in a period not exceeding 50 years at 6 per cent interest. The payments are payable half yearly, either by equal payment of principal with interest on principal for the time being outstanding, or by equal half-yearly payments of principal and interest combined by way of an annuity. This annuity, to repay a loan in 50 years with interest at 6 per cent per annum, is £3 3s. 4d. per £100 borrowed. £6 6s. 8d. as an annual payment will repay in 50 years both principal and interest of a loan of £100. This amount—£6 6s. 8d.—will be referred to later as the loan charge per £100.

Subsidies.—In addition to thus making loans to a public utility society the state will also grant them, with an annual subsidy, calculated as a proportion of the total loan, charges on the whole of the capital raised by the society whether obtained from the state or private sources.

The law provides that until 1927 this proportion will be 50 per cent and from 1927 until the government loan has been repaid the proportion of the loan charges subsidized by the state shall be 30 per cent. Also if no loan is obtained of the state the subsidy will be paid for a period of 50 years. Again, the proportion of the loan charge payable by the state is not affected by the rate of interest paid to private parties even if this rate is very much less than 6 per cent. The purpose of this is to encourage the utility societies to borrow from banks and individuals.

Illustration.—The following illustration of the working of this law is taken from a circular issued by the British Ministry of Health under date of January, 1920:

Suppose a society decides on building 50 houses to cost £800 each, including land, roads, etc., or a total of £40,000. The loan charges on this capital would be 400 × £6 6s. 8d. or £2,533 6s. 8d. The annual subsidy up to March, 1927, would be 50 per cent of £2,533 6s. 8d or £1,266 13s. 4d, and for the remainder of 50 years would be 30 per cent of £2,533 6s. 8d or £760.

Of the total capital £40,000 the state would loan three-quarters of £30,000, leaving the society to obtain £10,000 from other sources which we will assume is obtained at 3 per cent.

The following would be a specimen balance sheet for the period ending March 31, 1927:

Loan charge on state loan 300 x £6 6s. 8d.	£1,900		
Government subsidy	1,266	13	4
	£	S	d
	633	6	8
Interest at 3 per cent on £10,000	300	0	0
Repairs at £4 per house	200	0	0
Management, taxes, vacancies	160	0	0
	1,293	6	8
Rent at 10 shillings per week, exclusive of taxes	1,300		
Balance	6	13	4

It will be noted that the rent of 10 shillings ($2.50) per week is very much less than the economic rent. Where the British government rent restrictions are removed the rent of houses in general will tend to rise until the new "economic" level has been reached. The rent restrictions laws do not apply to the new houses, but naturally the rents obtainable for such houses will depend in some measure on the rents obtainable for similar existing houses.

An important reason for the state aid is the imperative need of houses, and properly enough the state's offer is limited to such projects as can show remarkable progress before Aug. 1, 1920. It is expected that the housing projects will be completed before July 31, 1922.

Sale of Houses.—Government subsidized houses may be sold by the consent of the government Loan Commissioners, but only at the market price, which must not be less than the following prescribed minimum prices based upon the approved value, or the outstanding amount of the loan raised to defray the capital cost of building and improvements:

MINIMUM PRICES OF SUBSIDIZED HOUSES.

If the sale is completed	the minimum sale price will be
Before April 1, 1921,	63 per cent of approved value
Before April 1, 1922,	64 per cent of approved value
Before April 1, 1923,	65 per cent of approved value
Before April 1, 1924,	66 per cent of approved value
Before April 1, 1925,	67 per cent of approved value
Before April 1, 1926,	68 per cent of approved value
Before April 1, 1927,	69 per cent of approved value
After Mar. 21, 1927,	70 per cent of approved value

The variation of the percentages during the years 1921-1927 is due to the fact that the annual subsidy for these years, viz., 50 per cent, is capitalized at the date of sale and applied in reduction of the outstanding loans. Thus the prescribed minimum sale price is the amount of the outstanding loan less the capitalized value of the subsidy at date of sale. A sale at the minimum sale price thus gives the purchaser the full benefit of the subsidy and at the same time extinguishes all loans.

The houses may be sold for more than the above minimum prices, and if so, the excess is due to the society which takes the initial risks in building the houses. Houses can be sold only to the occupiers and such purchasers must agree with the society that in the event of his ceasing to occupy the house, or in the event of his death, the society shall have the right to buy back the house at its original cost, less the depreciation. This clause is devised to prevent speculation in subsidized houses. In general it is expected to sell subsidized houses rather than to rent them.

Additional Subsidy.—Under a law passed December, 1919, the following subsidies were offered to private persons or bodies of persons constructing houses under certain specifications, provided such houses were completed before Dec. 23, 1920.

(a) Houses containing two living rooms (i. e., living room and parlor), and three or four bed rooms and comprising not less than 920 sq. ft. of floor area £260 per house.

(b) For houses containing one living room and three bed rooms, and comprising not less than 780 sq. ft. of floor area, £240 per house.

(c) For houses containing one living room and two bed rooms and comprising not less than 700 sq. ft. of floor area, £230 per house.

(d) Houses begun before April 1 shall be entitled to a subsidy of £50 additional above that given in paragraphs (a), (b), (c).

(e) No grant shall be given to houses of more than 4 bedrooms or exceeding 1,400 sq. ft. of floor space.

How the English Housing Laws Have Worked.—A question of much interest to those who have read the foregoing explanation of English laws designed to solve the national housing problem is "how have these laws worked out," and is there ground for the hope that they will accomplish their object.

The English Ministry of Health publish under date of May 21, 1920, the following facts:*

1. In the two weeks ending May 15, 1920, local authorities and public utility societies had submitted 158 housing schemes, including 4,073 acres, providing for 5,812 houses, and that contracts had been let for 3,652 of these houses.

2. That the total applications for subsidies up to May 15 numbered 10,016, comprising an area of 65,710 acres and providing for the erection of 197,232 houses of which 102,301 houses were under contract.

After personally inspecting some thousands of these houses and noting the general interest taken by the public in the purchase of local housing bonds, the writer is convinced that the housing problem is England is in safe hands

---

*See Journal "Housing," page 316, under date of May 24, 1920.

COST OF RECENT HOUSES (ENGLISH) RECEIVING APPROVAL AND ASSISTAN[illegible] GOVERNMENT.

	Non-Parlor Types. Living room, kitchen and					Parlor Types.				
Cost as approved.	1 bed-room.	2 bed-rooms.	3 bed-rooms	4 bed-rooms	Average cost per house	2 bed-rooms	3 bed-rooms	[illegible]	Average cost per house	Total number of houses.
$2,500	4		134	.	$2,[illegible]					1[illegible]0
$2,500-$3,000	..	[illegible]	[illegible]19		2,850	1[illegible]	[illegible]		2,[illegible]	11[illegible]
3,001- 3,500		[illegible]41	[illegible]	6	[illegible]		[illegible]			1[illegible]
3,501- 4,000		18[illegible]	5,[illegible]	[illegible]	3,800		[illegible]	..	[illegible]	[illegible]461
4,001- 4,500		[illegible]	7[illegible]7	4	4,140	[illegible]	[illegible]	[illegible]	4,[illegible]	[illegible]
4,501	..	[illegible]	119		[illegible]	11	[illegible]	[illegible]	[illegible]	[illegible]50
	4	[illegible]	9,[illegible]	1[illegible]	$[illegible]	105	1[illegible]	[illegible]	$[illegible]	27,[illegible]
		[illegible] (1)				16,[illegible]				

(1) Average cost of [illegible]6 houses is [illegible] $[illegible] (2) Of th[illegible] were in [illegible] districts [illegible] were in rural districts.

and bids fair to be solved in a reasonable time if present progress can furnish a criterion. This brief resume of English housing efforts is of interest to Americans for two reasons, first, as illustrating a new field in which local municipal authorities can serve their constituencies. For many years cities have built streets, sewer and water systems, parks and playgrounds, town halls and auditoriums, public markets and municipal docks and even voted large subsidies to manufacturing companies to insure their location in the city—all these expenditures of public funds and many other similar ones have been made to insure the health, pleasure and prosperity of the city's citizens. The national housing shortage adds a new and overwhelmingly important demand for municipal aid either in the form of subsidies or in the loss of the city's credit, insuring a low rate of interest on capital used in house construction. The importance of securing a low rate of interest for capital used in house building is of first importance. Realizing this fact the Canadian federal government has granted $25,000,000 as loans to municipalities for house buildings at 5 per cent interest, thus losing 1½ per cent interest.

If it could be found that present laws do not suffice to allow this being done in United States then new ones must be secured to the end that the most vital possession of all—a home—may be furnished to even the most modest citizen. A decent home is the safest insurance against the vagaries of bolshevism.

A second lesson furnished by the English experience is this: All classes of citizens are responsible for present bad and inadequate housing conditions and all must interest themselves in the problem and contribute to its solution. The general subscription to local housing bonds now being made in England points a practical and most efficient manner in which the average citizen can show his interest in the most vital problem which faces America, in fact faces the world. To continue the present laissez faire attitude or to hesitate because of real or fancied obstacles is unworthy of progressive America. If new laws are needed by way of extending the power of municipalities to build houses for its citizens, or even if the state constitution must needs be amended, Wisconsin certainly will continue to protect the vital interests of its citizens in the future as in the past. We have already at least one American state which has had the courage and the statesmanship to serve as an example—Massachusetts.

Private companies have scant ground on which to base objection to municipal co-operation and assistance. Experience of the most enlightened European countries show that there is room for all possible housing efforts, private and municipal. Who can doubt that in our own America where competent authority has shown the present imperative need of 1,000,000 houses, the field can be filled by private means alone. The country has always depended upon private capital to supply housing needs, with the result that even before the war a great deficiency in housing was widespread over the entire country. The importance of providing a home based upon American standards of living for every family, however humble, is too vitally important to the security of American ideals and American institutions to be longer neglected or left to the chance provision of private endeavor.

More fundamental than the deporting of alien bolshevists, is the adoption of housing policies which shall limit or prevent their creation. The fierce resentment toward society cherished by certain of its members often has a real basis, and in fact the lack of a decent home life is most often the primal cause of this feeling. Jacob Reis has said, "You cannot expect people to live like pigs and be good loyal citizens." In a great and true democracy such a condition should be impossible. We all share the duty and the responsibility of making it so.

Reproduction of Drawings by Photostatic Process

The advantages of the reproduction of drawings by the direct photographic copying process, as done with the photostat and other like machines is pointed out by Mr. L. N. Gillis in a recent issue of the American Machinist. Mr. Gillis writes:

"During the war, it was my fortune to have charge of the drafting office of the National Research Council. When I took charge of the office, I found the sizes of drawings prescribed by the man who had started the work, were standard sizes adopted from the drawings used in a sewing machine factory. I also found that the institution possessed a photostat machine of large size, and it was a simple matter to establish sizes for the drawings that would correspond with the standard sizes on the photostat scale. Then the drawings, either pencil drawings or tracings, could be laid on the photostat board and all reduced to 18x22 in., or a half or quarter thereof. When using the half size either two prints were made at a time or the half-size shield was put on the photostat. This method enabled as many reproductions to be made directly from the drawing as were necessary for our purposes; and, in addition, if a change was made on any drawing, the same could be reproduced without making a new zinc plate or a new photographic plate, since the printing was done directly on the photostat paper.

Moreover, the cost of this work is little more than the cost of the ordinary blueprint, and is certainly much less than would be the case with any small number of reproductions made by either a zinc-plate process or a photographic process on glass to any reasonable size. There is a happy medium between a small photograph and a blanket-sized blueprint that can very readily be reached with the photostat; and, in addition, it is possible to do with this latter class of reproduction all that can be done with either the zinc or photographic-plate process without requiring the lines and figures to be made abnormally large and heavy, since the drawing reproduced in this way to a size 18x82 in. comes out very distinctly, even though the drawing itself may be 48 or even 60 in. long. Again, convenient portfolios may be made up, all of 18x22-in. size, showing all of the drawings for any particular machine or apparatus.

"Of course, it is to be understood that where small details are made, they can either be photographed to full size or reduced from the original by placing a number of them on the printing board of the photostat. There are a number of machines of this class in the market, and, so far as I can find out, are all about equally good, and the operation is extremely simple in almost every case."

Blasting Down a Brick Wall.—Dynamite was used successfully by a Gainesville, Fla., in cutting down a 150-ft. long brick wall for the Florida Industrial Corporation. The wall was 22 ft. high and 18 in. thick and rested on a concrete foundation 18 in. below the ground level. It was desired only to take down the wall to the surface, so it was not necessary to disturb the concrete. Twenty-six holes were cut into the wall just above the ground and 2½ lb. of 30 per cent ammonia dynamite were tamped with clay in each hole. The charges were connected up in series and fired with electric blasting caps. The wall was cut down clean at the ground level. The work was all done by one man in less than a day. The total cost, including labor, was about $26.

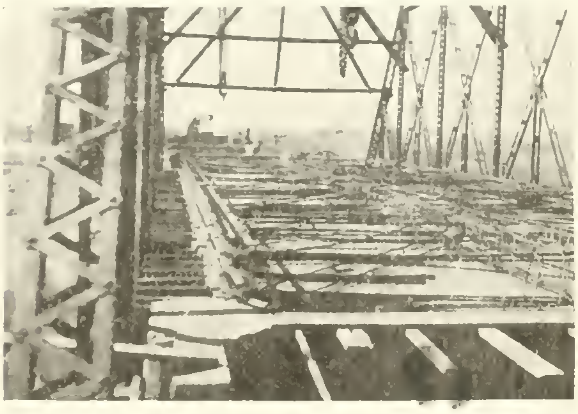
Reinforced Concrete Truss Bridges Erected Without Falsework

By the elimination of falsework and a reduction in forms, a considerable saving in time and money was possible in the construction of the attractive reinforced concrete truss bridges at Wichita Falls, Texas, Las Vegas and Las Alamas, N. Mex.

The methods of handling the work were described in the October-November issue of Concrete in Architecture and Engineering, to which we are indebted for the matter in our article.

Reinforced Concrete Bridge at Las Alamas, N. Mex.

The elimination of falsework was accomplished by using a pair of steel trusses as a part of the construction equipment. These trusses were later sold at cost and used as highway bridges. They were made in the usual manner, except that the lower chords had channel sections to provide a support for a temporary plank floor, and to permit moving the trusses on rollers. The temporary floor placed on the lower chords supported the concrete trusses, which were cast in a horizontal position, one pair at a time. This arrangement in turn eliminated most of the form work, since forms were needed only on the sides of the truss members.


The Concrete Trusses Were First Cast in a Horizontal Position on the Floor of a Temporary Steel Bridge. The View Shows the Reinforcement in Place Ready for Form Work at Wichita Falls Bridge.

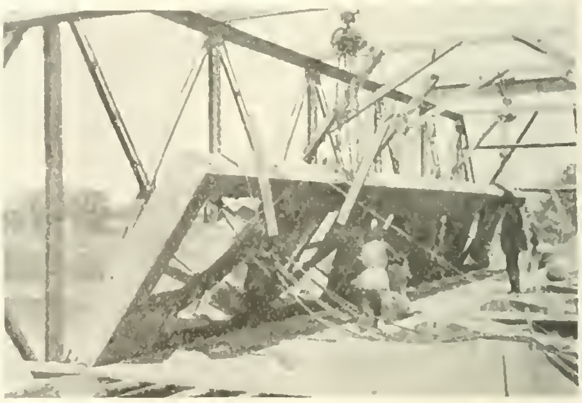
The largest of the three bridges is at Wichita Falls, Texas, over the Wichita River. It consists of six spans of 66 ft. each, with a 20-ft. roadway and two 5-ft. sidewalks. After the steel trusses were in place and the temporary floor had been laid, the reinforcement for a pair of concrete trusses was placed on the floor adjacent to the positions to be occupied in the completed structure. The forms, consisting of simple triangular frames or bottomless boxes, were then set on the floor and the concrete deposited. After it had hardened, the cast truss was raised to the vertical position by block and tackle, as shown in one of the illustrations. The steel trusses were then moved forward to the next span, first on rollers supported on the top chords of the concrete trusses, and later, after the movement was half completed, on another set of rollers underneath the bottom chords of the concrete trusses. In this manner the steel trusses were cantilevered across the span to the next pier.

An ingenious method was used in casting the concrete trusses to insure a perfectly straight product. This was accomplished by providing a camber in the steel trusses of an amount such that the weight of the concrete trusses would straighten the camber. All concreting material needed was then placed on the floor and distributed uniformly along the span before any concrete was deposited. In as much as this material was changed in form only, no change in weight or further deflection of the steel trusses occurred after the placing of concrete was begun.

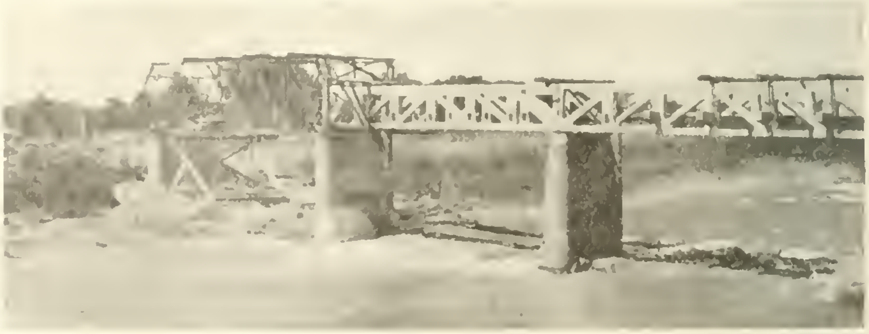
Provision for supporting the transverse floor beams was made at the time of casting the trusses, rectangular openings having been left in all vertical members. These openings were beveled to give the floor beams a secure bond, and also served as supports for the floor beam forms. The floor beam reinforcement was passed through the openings and continued as reinforcement for the cantilever brackets supporting the sidewalks. The brackets are in fact continuations of the floor beams. One of the illustrations shows these rectangular openings, with several floor beams and sidewalk brackets in place.

The bridge at Las Alamas, N. Mex., consists of four spans of 80 ft. each. It was built in a manner similar to that just described.

At Las Vegas, N. Mex., some departure from the usual procedure was made. Because of the shallowness of the stream bed and because rains were not feared at that season of the year, the steel truss equipment was dispensed with and the concrete trusses were cast on platforms laid on the stream bed, directly under their final positions in the completed bridge. They are then lifted into place.


Raising Concrete Trusses to Vertical Position.

The contractor states that he can always dispose of his steel trusses to good advantage, in cases where he finds it impracticable to use the same trusses on another contract. Those used on the Wichita Falls and Las Alamas contracts were sold at cost for highway bridges. In another instance he obtained the contracts for several concrete bridges and one steel truss bridge, all of equal span. He designed and built a pair of steel trusses to erect the concrete bridges, after which he used the steel trusses in the bridge for which they were specified. By planning his work in this manner and designing the trusses for possible future use, a contractor is able to obtain high salvage on the steel.


Two Concrete Trusses Erected and Temporary Steel Bridge Moved Ahead to Next Span.

The Jenkins Bridge & Construction Co., 735 S. Logan St., Denver, Colo., had the contract for the bridges described.

What an Employer Requires When Engaging an Engineer*

By FRANK D. CHASE,

President Frank D. Chase, Inc., Engineers, Chicago

The employer divides his resources into material and labor. Material in any form whatever is represented by capital or represents capital.

The inventory or list of assets of any firm take cognizance only of material as representing capital investment. The banker looks at the inventary before making his loan, corporations are financed on the inventory and all the plans of a going concern are based on inventory, or some form of material investment.

I have to speak briefly of the other of these two subdivisions of industry; that is, labor, and specifically of the engineer and of his being employed—in other words, I am to discuss what an employer requires when engaging an engineer.

It is quite true that material forms the basis of inventory or a value measure of a going concern, but an important, although intangible thing, is the element of labor. By labor I do not mean merely manual or physical effort—labor is defined as mental or physical actvity.

Importance of Personnel of Organization.—It is quite true that the banker looks at the physical inventory when making his loan, but it is also true that without the consideration of labor, or personnel, the inventory does not go very far with the banker, nor does it go very far with the average business man; in other words, the labor or personnel of an establishment or institution is quite as important as the material element and frequently far exceeds it in importance.

The U. S. Steel Corporation with its hundreds of millions of invested capital would be a failure as a going concern without the guiding master mind of Judge Gary and his able subordinates who execute the policy of the corporation. Without the personnel who comprise the management of this corporation it would consist of merely an aggregation of large manufacturing plants, which might or might not produce profitably and which could not exist were it not for the intellectual labor which controls and executes.

The men, then, who execute and form the big part of the personnel of the organization must be considered as of the utmost importance and their selection carefully studied in order to secure a proper personnel.

The apprentice of today is the executive of tomorrow, and the necessity of care in the selection of men is recognized by the modern employer, regardless of the character of the position or its relative importance in the organization. The large corporations frequently make the same complete investigations and analysis in the employment of an office boy that is made in the selection of a $10,000 man.

What I have said may be considered in the light of a generality, but it is not. I have merely stated a few fundamentals and they apply with equal force to the employment of the engineer. This is particularly true in the light of present day practice of using engineers or men of engineering training and some engineering experience in responsible positions in almost every line of industrial activity.

Important Considerations in Selection of Employes.—Realizing the importance of the proper personnel of an organization, the employer who does not formulate a very definite plan for the employment of his assistants is making a very serious mistake and I shall outline briefly, from my own experience, what appears to me as being the important considerations.

It seems rather unscientific to speak of "hunches," but when I interview a man for employment it takes me considerably less time than it has taken me to say it to size up a man and place him. Subsequent conversation and data serves to corroborate or verify my first impression. The first size-up naturally separates itself into two divisions: first, the physical qualifications of the man; second, the mental qualifications. Physical qualifications should include good health, which is reflected by an upright, alert bearing, and personal appearance as indicated by clothing and the way it is worn. [illegible] there is no excuse for a man who calls himself an engineer, unless he is wearing field clothes, to wear other than neatly pressed clothing, together with clean linen and shined shoes. Slovenly mental traits are reflected by slovenly attire and I have little respect for such a man. It is true that the genius sometimes forgets to shave and wash and that the old adage says that a man must not be judged by his clothes, but we are not looking for geniuses, and if I put one in the discard because of this elimination test, I shall not regret it. In 99 times out of a hundred, a man's physical appearance does indicate to a great measure his mental characteristics and qualifications and thereby reflect his personality, of which I shall speak later.

A man's mental attitude is reflected by the style of his greeting and one can determine a man's ability of presentation by the way he presents himself.

Characterizations which one notes are aggressiveness, tempered by good taste or breeding, straightforwardness, or clear or logical thinking which is exhibited by his ability to state his case briefly and without undue loquaciousness. A man's mental qualifications and mental capacity are indicated at the outset by these manifestations, all of which may be determined within a minute's time. The facts may then be brought out which are essential in any engineer and these include:

First—Loyalty.
Second—Personality.
Third—Experience.
Fourth—Education.

The Value of Loyalty.—I have outlined these four principal items in the order in which they appear to me as being essential and in this order can the facts be determined when employing a man. I place loyalty first. This word is susceptible of rather a broad interpretation and this is the interpretation I put upon it. Loyalty means loyalty or honesty of conviction or purpose, first, to one's self. If one is lowal to his own conviction of right he is loyal to his employer.

When I started out a few years ago as a cub engineer I took the attitude that I had no boss but my own conscience and ambition. It has been my experience ever since leaving college, and beginning as a rodman, that I have been in responsible charge of work without coming in contact personally with a boss. My first job, as I say, was a rodman. As a matter of fact, I had a small party of men in the field and it was my pleasure, although not necessary, to report about once a week to the engineer in the division, comprising about 300 miles, outlining to him what I had done during the past week or so and what I proposed to do. The execution of that work was in my hands entirely. I could work all day, play all day and nobody was the wiser and it was strictly up to me. I was governed entirely by a sense of loyalty, and when I say loyalty to myself and my feeling that I had no boss, I mean it was simply up to me to make good for my own best interests, because therein lay the best interests of my employer. I figured that if I made good for myself I was making good for my employer. Of course this is true; if I make good for my employer I make good for myself, but as an individualist I put it the other way around and we are all individualists in the last analysis. We are all out for what we can get—nearly all of us with the thought of getting it honestly; some, and they are few, fortunately, with the thought of getting it dishonestly.

Loyalty to one's self and one's employer means honest work, and its reward, promotion, increase of responsibility and salary—and the men who have the ambition to attain these are the men we are looking for.

The simple test for loyalty is to get the applicant to talk about his present or former employers. The man with a grievance should be watched, and the man who criticises his treatment and lack of opportunity, is usually lacking in loyalty. I believe that it's the exception, rather than the rule, that a man fails to get proper consideration of his services and opportunities for advancement. Opportunities abound, the average man is waiting for the opportunity for advancement to be given him. It won't be, but he can, in a million ways, seize the opportunity and profit thereby.

Personality.—My second classification is personality—rather difficult to define, but to me it means the expression, outwardly, of one's self. We speak of an agreeable, a strong, dominant or compelling, or an intelligent personality. All the knowledge in the world is of no avail if one cannot apply it and use it for the benefit of those whom he is paid to work with.

---

*Paper presented Nov. 12 at the Conference on Employment and Education sponsored by the American Association of Engineers.

The right personality permits a man not only to do himself and his work justice, but to co-operate with his fellowmen, developing thereby teamwork a vital necessity for the proper functioning of any organization.

A man's personality is reflected by his every act and speech, oral or written, and therefore can be observed at any and all times, and easily studied during an interview.

Experience.—My third qualification is experience. I grant that without experience, loyalty and personality are without value, but mere experience is a drug on the market. There are too many men who can teach us the contents of all the engineering text books in the library, and they call themselves engineers. I do not so consider them. It takes more than mere technical knowledge to earn the title engineer. For a given job, however, certain experience is essential, and it is an easy matter to determine whether or not an applicant fits, so far as experience goes. References as to experience and other capabilities are, in my opinion, of little value and I place little value upon them. It is a rare occasion for me to condemn a man in such a way that I interfere with his chances for employment, and I believe that is true of most of us.

Experience is not always a matter of years. There again does personality enter, and one man's work for a year may better fit him for a similar line of work with greater responsibility than five years' work by another man.

Experience is a splendid, if somewhat costly teacher, but the man of judgment learns rapidly.

Education.—Education is the last of my qualifications, and the least important. It's not what a man has learned, but what he knows, and his ability to apply his knowledge. By application I mean, for instance, the knowledge of where to find specific data—that's better than burdening the mind with masses of statistics which cannot be relied upon.

The college man has a splendid advantage, or a serious handicap, depending on how he makes use of his education. The man who digs out his education in a night school better appreciates what he has. He got it because he wanted it, not because it was handed to him. The percentage of successful correspondence or night school graduates is high, I imagine.

These four qualifications are all susceptible of record, and a record can be made of each, and many large corporations are giving keen study and analysis to the men whom they employ. These records are used not merely as an entrance requirement but are the basis of transfer and promotion. In other words, the employment of men is being put on a scientific basis—a good job for the engineer!

In closing I want to say, without apology, that I have treated this subject briefly, but have, I believe, covered the essentials. The points discussed are, I believe, fundamental. Whether you agree with me or not, I do not think there is much difference in the fundamental analysis required, whether we are employing engineers or street sweepers.

It's a matter of common sense, which Professor Swain used to say should be called "uncommon sense"—it's so rare. Engineering is merely the application of common sense to a specific field of human endeavor, and we want men, not automatons.

Office Hours of New York City Architects and Engineers. The range of office hours for important New York City engineering and construction firms and architects, was recently the subject of a brief investigation by the Merchants' Association's Industrial Bureau of New York City. Of eight architects' offices investigated, all open at 9 o'clock and close at 5 daily, closing at 1 o'clock on Saturday. In some cases this is varied during the summer months: One firm opens at 8:30 and closes at 5:30 daily for five days, remaining closed all day Saturday; another firm retains its winter hours five days a week, but remains closed all day Saturday; still another firm closes at 12 o'clock instead of 1 on Saturdays. Of 12 engineering and construction firms investigated, 7 have hours from 9 to 5 daily (5 of these 7 close at 1 on Saturday, 1 at 12, and 1 at 12 or 12:30), 1 opens daily at 9 and closes at 5 or 5:30 (closing Saturdays at 12 or 1), 2 open at 8:30 and close at 5:30 daily (1 closing at 1 o'clock and 1 at 12:30 Saturdays), another opens at 8:15 and closes daily at 5:15 (closing at 1 on Saturday), and still another opens at 8 and closes daily at 5:30 (closing at 2 on Saturday).

The New Canadian Steel Railway Bridge Specification

After 16 months' work the Canadian Engineering Standards Association's sectional committee on steel bridges and construction has issued a standard specification for steel railway bridges. In this an effort has been made to avoid limiting the engineer's choice as to type of bridge, so that he may have latitude to exercise his personal ingenuity and to develop the best type of construction and details that he is able to create. The specification is in reality the work of the two societies, the above mentioned and in the Canadian Society of Engineers. It is a revision of the specifications adopted and issued by the latter organization in 1912.

In view of the obvious desirability of agreement between a Canadian specification of this kind and similar documents prepared by engineering bodies in the United States, the committees responsible for the Canadian Engineering Standards Association's specification carefully considered the bridge specifications of the American Railway Engineering Association and the specifications (for bridge materials) issued by the American Society for Testing Materials. The new Canadian specification in its present form, while not in absolute agreement with the American specifications on all points, is in substantial agreement therewith, the principal points of difference being such as have been found desirable in view of Canadian conditions.

The following outline of a few characteristic paragraphs of the specifications is taken from The Canadian Engineer:

The new specification applies only to steel railway bridges of span not exceeding 500 ft. and does not cover the design of suspension bridges nor of turntables for locomotives.

The clearance diagram for bridges on tangents is based upon that given in the Canadian Society of Civil Engineer's specification of 1912, the difference being that the side clearance for the first 3 ft. 3 in. of height is somewhat increased by the introduction of a re-entrant angle. The provisions for curvature of track are substantially the same as those in former specifications.

For through bridges with two or more tracks the tracks are to be spaced as required by the engineer, but not less than 12 ft. c. to c., a reduction of 1 ft. from the usual requirement.

Floors.—For timber floors, cross-ties are to be proportioned for maximum wheel-loads with 100 per cent impact, distributed uniformly over 3 ft. of track. They are to be spaced not over 4 in. in the clear and to have a minimum length of 13 ft., a reduction of 1 ft. from the usual requirement.

For ballasted floors the provision of the specification is as follows:

"Transverse girders and trough sections for supporting ballasted floors shall be proportioned for the maximum wheel loads with 100 per cent impact, distributed uniformly over 3 ft., or a length of track equal to twice the depth of the floor (measured from the base of the rail to the top of the supporting steel-work). Reinforced concrete slabs shall be proportioned for the same wheel loads and impact as above, distributed over 3 ft., or a length equal to twice the depth of the floor (measured from the base of rail to the upper side of the slab), and in accordance with the Engineering Institute of Canada's Specification for Reinforced Concrete."

Live Loads.—The specified live load is of the Cooper type, ranging from E-30 to E-80, with an alternative loading of from 75,000 lb. to 200,000 lb. on two axles spaced 7 ft. apart.

Impact is to be calculated in accordance with the formula of the American Railway Engineering Association,

$$I = 30{,}000S \div (30{,}000 + L^2),$$

in which I = impact stress; S = statically computed maximum live load stress in member considered; L = loaded length of track, in feet, producing the maximum live load stress. (For stringers, the loaded length shall be taken equal to that of one panel; for floor beams, two panels.)

Lateral Forces.—Some members of the committees held the view that lateral forces should be figured on the basis of exposed area for all bridges, but the specification as finally adopted provides that these forces be calculated for ordinary fixed bridges on the basis of a specified force per running foot. Provisions respecting these forces are as follows:

"Fixed bridges shall be designed for a horizontal wind force of 200 lb. per lineal foot, applied to both upper and lower chords; and a further horizontal force equal to 10 per cent of the specified uniform live load for one track, applied 8 ft. above the base of rail; all of which forces shall be treated as moving loads acting at right angles to the longitudinal axis of the bridge."

Longitudinal Forces.—The new formula for the computation of longitudinal forces produced by the traction of the engines or the application of the brakes to a moving train is as follows, the assumption being that the calculated force is applied 6 ft. above the base of rail:

"For loaded lengths up to 400 ft., the longitudinal force shall be computed by the formula, $T = \frac{3}{4}(1 - L \div 10)$, in which T = longitudinal force, in percentage of the live load; and L = loaded length, in units of 100 ft."

Temperature Stresses.—To indicate clearly how much of the length variation should be provided for as contraction and how much as expansion, it is specified that the variation shall be from a normal temperature of 60°, through a range of 40° below zero to 120° above zero.

Combined Stresses.—Provision for combined stresses is made as follows:

"The various parts of the structure shall be proportioned for the maximum stresses produced by a combination of co-existing dead load, live load, impact and centrifugal force (if any); or for wind load, longitudinal and temperature stresses (separately or combined), by using the unit stresses due to co-existing wind load, longitudinal force or variation in temperature, with dead load, live load, impact or centrifugal force, the specified unit stresses shall not be exceeded by more than 25 per cent.

Secondary Stresses.—There has been considerable discussion regarding the desirability of providing in a specification of this kind for secondary stresses. As a result, the provisions under consideration by the committee now drafting the revised bridge specification for the American Railway Engineering Association have been used, but the clause is not mandatory; its adoption is left to the discretion of the engineer. The clause is as follows:

"When specified by the engineer, secondary stresses in trusses, due to the deformations produced by the dead load and live load, shall be computed, in which case the total fiber stress resulting from all axial and bending stresses due to dead load, live load, impact and centrifugal force shall not exceed the permissible axial unit stress by more than one-third. With the further addition of stresses due to wind load, longitudinal force, or change in temperature, the total fiber stress shall not exceed the permissible axial unit stress by more than 50 per cent.

Unit Stresses.—The subject that is said to have occasioned the most discussion among the members of the committees was the column formula. While it was recognized that it would be desirable to adopt the same formula as that likely to be adopted by the American Railway Engineering Association, the committee devised an independent formula,

$$p = 12{,}500 - 0.25(l/r)^2.$$

It was deemed that this formula adequately expresses the safe strength of columns in the light of the recent tests of the American Society of Civil Engineers, and also of former tests; and that until a formula based upon an exhaustive study of all available tests is adopted, the one presented will serve satisfactorily.

Various other changes in working stresses have been adopted, including among others the increase of shearing and bearing stresses on shop rivets from 11,000 and 22,000 to 12,000 and 24,000 lb. per square inch, respectively.

The use of structural nickel steel is provided for at working stresses 40 per cent in excess of those adopted for carbon structural steel.

Proportioning of Parts.—Although there was not absolute unanimity among the members of the committees on the matter of net sections for tension members, the following rule, which is simple of statement, was finally adopted:

"In proportioning riveted tension members, the diameter of the rivet holes shall be taken ⅛ in. larger than the nominal diameter of the rivet; and allowance shall be made in each component part of the member for as many rivet holes as it contains gage lines, unless the distance center to center of rivet holes, measured on the diagonal, is at least 40 per cent greater than the distance between the gage lines. In every angle, allowance shall be made for at least two rivet holes."

The limiting value of the slenderness ratio is placed at 175, but for built-up I-sections the radius of gyration may be computed for the flange material alone, neglecting the web plate, in which case the plates shall not be counted on as effective section for axial compression.

No distinction is made between web plates and cover plates in the matter of ratio of distance between rivet lines to thickness, as will be seen from the following:

"Cover plates and web plates of built compression members, likewise plates on the compression flange of girders, shall have a minimum thickness of one-fortieth of the unsupported transverse distance between the lines of connection rivets."

Unstiffened flanges of girders and of main compression members must have a minimum thickness of one-twelfth of the unsupported length of the outstanding leg. For wind bracing and other secondary members, this minimum thickness is fixed at one-fourteenth.

The lack of lateral rigidity of pony truss bridges is dealt with in the following paragraph:

"In all pony truss bridges, the floor beams shall be rigidly connected to vertical truss members; and stiffening gussets, as large as practicable without interfering with the required clearances, shall be provided. The vertical truss members and the connections of the floor beams thereto shall, when practicable, be proportioned to resist at the specified unit stresses, a lateral force applied at the top chord of the truss equal to 2 per cent of the maximum top chord stress. When impracticable to design the vertical truss members and connections of sufficient strength to meet this requirement, outside wing braces shall be added."

Plate girders may be proportioned for bending moments, either by the moment of inertia of net section or by assuming the flanges as concentrated at their center of gravity. In the latter case, one-eighth of the gross area of the web may be assumed as equivalent to net section for the tension flange.

The design of web plates is covered in part by the following provision:

"Web plates shall be so proportioned that the permissible shear on their gross section will not be exceeded. This rule applies to both vertical and horizontal shearing stresses; and careful consideration shall be given to the latter, which frequently govern at the ends of plate girders. Splices in web plates shall be avoided as far as possible, but, when necessary, they shall be designed so that the full value of the web plate will be uniformly developed, both for bending and for shear."

It is recommended that end floor beams shall be provided wherever possible and that they shall preferably be designed for jacking up the bridge, if necessary, under which condition the allowed unit stresses shall not be exceeded by more than 50 per cent.

Bracing.—Carefully framed provisions cover the bracing of all structures. Following is a characteristic citation from the specification:

"Lateral, longitudinal and transverse bracing shall be rigid, and shall be proportioned (1) so that the unsupported length thereof will not exceed 175 times the least radius of gyration; (2) so that the fiber stress resulting from their own weight will not exceed the allowed axial unit stress for compression; (3) so that the fiber stress resulting from their own weight, combined with any computed axial stress, will not exceed the allowed axial unit stress for tension or compression, as the case may be."

Details of Design.—The following provisions covering details of design are indicative of departures made in the present specification from former Canadian railway bridge specifications:

"Pin plates shall be of sufficient thickness to make up the required bearing area upon the pin; they shall be as wide as the dimensions of the member will allow; and their length, measured from pin center to end, shall be at least equal to their width. Pin plates shall contain sufficient rivets to distribute their due proportion of the pin pressure to the full cross section of the member; and only the rivets located in front of two lines, intersecting at the pin center and inclined at 45° to the axis of the member, shall be considered effective for this purpose.

"Tension members shall be connected or spliced for an axial stress equal to their net sectional area, in square inches, multiplied by 16,000 lb. per square inch. Compression members shall be connected for an axial stress equal to their gross sectional area, in square inches, multiplied by 12,500 lb. per square inch. Truss members subject to reversal of stress shall be connected for an axial stress equal to the arithmetical sum of the maximum resultant axial stresses of both kinds. Lateral, longitudinal and transverse bracing, when subject to reversal of stress, shall be connected for the maximum value whether in tension or compression.

"Compression members abutting on a pin shall have sufficient bearing thereon to transmit the entire thrust without exceeding the allowable unit bearing. In riveted structures, continuous compression members, such as chords and trestle posts, shall have faced ends and full contact bearings at the joints when riveted. All joints in compression members, where pins are now used, shall be spliced for an axial stress equal to the gross sectional area of the smaller abutting members, in square inches, multiplied by 12,500 lb. per square inch.

"The latticing of compression members shall be proportioned to resist a transverse shear equal to 2 per cent of the axial stress in the member, which shear shall be considered as divided equally among all stiffening parts in parallel planes, whether of continuous plates or of latticing."

Movable Bridges.—Movable bridges were included in the present specification, instead of a separate specification being prepared for such structures, because of the fact that the Department of Railways and Canals' specification includes movable bridges, so it was thought advisable that the new specification, which may conceivably succeed the Government's specification, should also include these structures. The requirements are in considerable detail, and although they may be criticised to a certain extent, the members of the committees are of the opinion that they include no more than can reasonably be asked of those who wish to obtain first-class work.

Provision is made that machinery supports and motive power shall be designed for the following wind loads and conditions:

"(a) A horizontal wind pressure of 15 lb. per square foot on the vertical projection of all exposed surfaces of the movable structure, acting in any horizontal direction and at any period during the operation of the bridge;

"(b) A horizontal wind pressure of 5 lb. per square foot on the vertical projection of all exposed surfaces of either arm of a swing bridge, acting at right angles to the longitudinal axis of the bridge;

"(c) A vertical wind pressure of 5 lb. per square foot, acting on the horizontal projection of all exposed surfaces of bascule and vertical lift bridges;

"(d) A horizontal wind pressure of 30 lb. per square foot on the vertical projection of all exposed surfaces of the movable structure, acting in any horizontal direction and at any period during the operation of the bridge.

"Swing bridges shall be designed to operate, at the specified speed, under condition (a); they shall be designed to operate, at reduced speed, under conditions (a) and (b) combined; and to be safe against movement under conditions (b) and (d) combined. Bascule and vertical lift bridges shall be designed to operate, at the specified speed, under condition (a); at reduced speed, under conditions (a) and (c) combined; and to be safe against movement under conditions (c) and (d) combined. All movable bridges, when closed and locked, shall be designed for the same wind loads as equivalent fixed spans."

Personnel of Committees.—The personnel of the committees responsible for the drafting of the specification was:

Sectional Committee on Steel Bridges and Construction W. A. Bowden, W. P. Chapman, W. A. Duff, G. H. Duggan (chairman); W. J. Francis, H. G. Kelley, C. N. Mansarrat, P. B. Motley, G. A. Mountain, H. B. Stuart, W. Chase Thomson and C. R. Young.

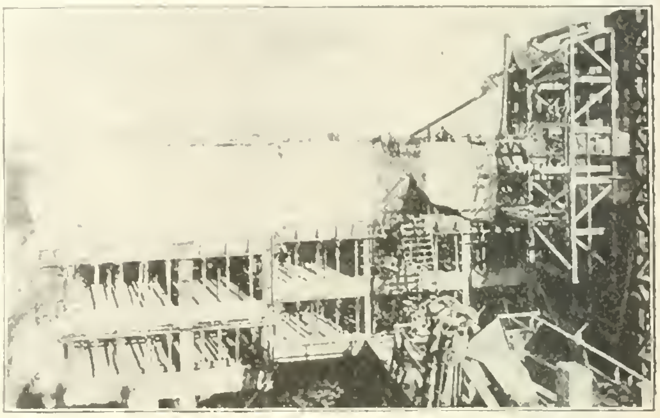
Sub-Committee on Steel Railway Bridges (also the Committee of the Engineering Institute of Canada on Steel Railway Bridges)—H. P. Borden, W. A. Bowden, F. T. Cole, G. W. Craig, G. H. Duggan, A. H. Harkness, H. A. Icke, A. E. Johnson, J. G. Legrand, M. A. Lyons, C. N. Monsarrat, E. G. W. Montgomery, P. B. Motley (chairman), F. P. Shearwood, H. B. Stuart and W. Chase Thompson.

Present Steel Prices to Remain.—The United States Steel Corporation on Nov. 19 announced its decision to recommend to presidents of subsidiary companies that the present base selling prices of all commodities continue in force unless and until it becomes necessary and proper to make a change to meet altered conditions.

Concrete Construction in Zero Weather

Concrete construction at the Somerset Hotel, Chicago, was carried on in December, 1919, and January, 1920, during sustained zero weather with temperatures running as low as 10° below zero. The work, which is of particular interest, because of the care taken to get accurate records of temperature of concrete from the moment it was mixed until it had hardened sufficiently to allow removal of the protection against freezing, is described in the October-November issue of Concrete in Architecture and Engineering, from which the matter following is taken:

Sand and stone in correct porportions for a concrete batch were fed into a mixer from an elevated storage bin, which was heated by steam pipes, the average temperature of these aggregates in zero weather having been maintained at about 70°. When the aggregates left the mixer, their temperature was from 68 to 70°. The aggregates were then elevated on a tower to heights varying from 60 to 120 ft., and then conducted to the floor by chutes varying from 100 to 140 ft. long. Concrete mixing took place on the floor being concreted, under the protection of tarpaulins. The temperature of the concrete at point of discharge into the forms was around 60° in zero weather, indicating a loss of 8 to 10° in the operation. In order to maintain a temperature of about 60° when the concrete went into the forms, the temperature of aggregates was varied to suit weather conditions. The mixing water was heated to about 80 to 100°. The cement was not heated.



Protection of Concrete During Cold Weather.

The floors were immediately covered with canvas held on frame work 5 to 6 ft. high. These tarpaulins extended down the side of the building over brackets extending out about 2 ft., to the floor below, where they were attached to the frame work. The brackets produced an air space of about 2 ft. at the level of the floor being concreted, and on all sides of the building, thus permitting circulation of the warm air. One salamander was located at each outside column and one at the center of each 16-ft. square bay. These were sufficient to hold the temperature of the air below the slab at about 68° and about 60° above it, at a time when the outside temperature was below zero. During this time the temperature of the concrete was about 60°. Slab temperatures were taken with thermometers suspended inside of small metal pipes set in the floor at various points.

There are 18,000 sq. ft. of space on each floor, of which one-half was concreted at a time. Each half required about 210 cu. yards of concrete. The best record in placing was nearly 40 cu. yd. per hour. During severe weather the concrete was covered as fast as it was placed. The cost was $11.13 per cubic yard, exclusive of steel and forms. As the work progressed on but one-half of the building at a time, the tarpaulins and the special forms used to hold them in place were used alternately by moving them from side to side. Very little time was lost, as the carpenter work on the forms required about the same time as the concrete required for hardening.

Paschen Brothers, of 111 West Washington St., Chicago, were the contractors. J. F. Denson supervised the work for the architect. The building was designed by S. N. Crowen, architect, Chicago, and the construction is being carried out under his supervision.

Effect of Age and Curing Conditions on Concrete—Results of Tests of Ten Year Old Specimens

Results of tests on 10-year-old concrete are given by M. O. Withey, Professor of Mechanics at the University of Wisconsin, in the November issue of The Wisconsin Engineer. The series of experiments were started in the Materials Testing Laboratory of the University in the summer of 1910, to receive information on the effect of age and curing conditions on the compressive strength of concrete. The complete series of experiments will comprise crushing tests on 450 6x18-in. concrete cylinders besides a number of tests of neat cement and mortar test pieces. In the original program, tests covering ages up to 10 years were planned, but after the series had been started it seemed best to spread the tests over a much longer period. It is now hoped that arrangements may be made to distribute the remaining tests so that the entire program will cover a 50-year period. Half of the concrete specimens were 1:2:4 proportions by volume; the remainder of 1:3:6.

Three curing conditions are in use:

1. Storage in a water tank at a temperature of 60 to 70° F.
2. Storage in a cage out of doors where the concrete cylinders rest with ends on the ground and are exposed to all conditions of weather.
3. Storage in a cellar which has a range in humidity from 50 to 75 per cent and a temperature range from 35° to 70° F.

Much care was exercised in making the specimens to secure uniformity in all operations so that the variation between test pieces would be as small as possible. Atlas portland cement, Janesville sand, and Madison crushed limestone were used in making the concrete specimens. They were mixed in batches of 15 in a No. 0 Smith mixer for a period of three minutes. About 10 per cent of water, by weight of dry materials, was required to obtain a concrete of proper consistency. When tempered with this amount of water, the mix flowed sluggishly from the shovel and was easily puddled with a rod during molding. Concrete specimens were cured three days in molds; marked, measured, and weighed on the fourth day; then sprinkled twice a day until two weeks old, when they were subjected to the various storage conditions. The cement and mortar test pieces reported herein were fabricated and cured in accordance with standard practice.

Five concrete specimens from every batch were subjected to each storage condition. The schedule of tests was so arranged that only one specimen of a given batch and curing condition was tested at a time. Five concrete and three or four mortar test pieces were broken at each test period.

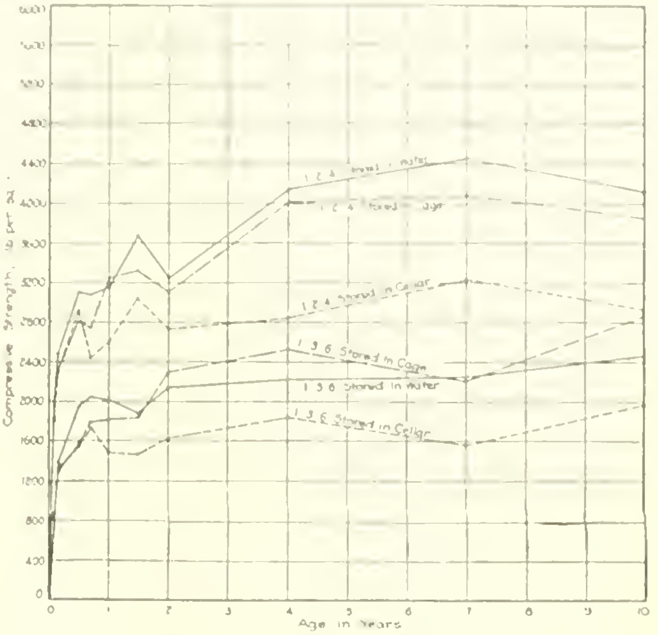


Fig. 1.—Strength-Age Curves for Concrete Cured in Various Ways.

Concrete specimens were stored in the laboratory one week

TABLE I
The Effect of Age on the Compressive Strength of Concrete Subjected to Different Curing Conditions

Materials: Atlas cement, Janesville sand, and Madison limestone (1¼ in. to ¼ in. in diameter).
Mixing: All materials were mixed in a No. 0 Smith mixer ¾ min. dry and 2¼ min wet.
Specimens: The cylinders were 6" in diam and 18" high. Fifteen specimens were made from each batch of concrete and were numbered consecutively
Curing: All specimens were cured in molds for 3 days and sprinkled for 11 days. They were cured as indicated. The storage water for the water-cured specimens was renewed about once every month; its temperature varied from 60°F to 70°F.

MIX:- 1:3:6 Water:- 10% of dry weight of materials — MIX:- 1:2:4 Water:- 10% of dry weight of materials

Specimen No	Age		Specific Weight When Tested lb/ft³	Percent Weight Lost in Curing	Maximum Load lb.	Ultimate Strength lb/in²	Average Percent Error of Mean	Average Ultimate Strength lb/in²	Ave Weather Conditions for Last Week in Cage				Specimen No	Age		Specific Weight When Tested lb/ft³	Percent Weight Lost in Curing	Maximum Load lb.	Ultimate Strength lb/in²	Average Percent Error of Mean	Average Ultimate Strength lb/in²	Ave Weather Conditions for Last Week in Cage			
	Years	Months							Percent Humidity	Temperature Degrees F.	Percent Cloudiness	Total Precipitation - in.		Years	Months							Percent Humidity	Temperature Degrees F.	Percent Cloudiness	Total Precipitation - in.
SPECIMENS CURED IN CELLAR																										
234	10	0	1416	302	54200	1925							9	10	0	1432	245	83000	2835						
279	10	0	150.4	342	53150	1900							54	10	0	1448	273	88000	3105						
324	10	0	1486	3.86	62500	2205							99	10	0	1444	228	85500	3015						
369	10	0	145.5	386	57260	1980							144	10	0	143.1	2.06	80500	2820						
414	10	0	1433	1.62	51200	1810	523	1964					189	10	0	147.6	229	82300	2910	3.35	2937				
SPECIMENS CURED IN CAGE																										
229	10	0	1480	1.25	72300	2590			64	696	40	Trace	4	10	0	1444	092	119500	4170			64	696	40	Trace
274	10	0	145.4	2.73	99870	3525			64	696	40		49	10	0	147.0	068	117300	4070			64	696	40	
319	10	0	144.0	1.62	75900	2680			64	69.6	40		94	10	0	1478	0.90	119300	4180			64	696	40	
364	10	0	146.0	226	78200	2765			64	69.6	40		139	10	0	1447	2.05	97500	3440			64	696	40	
409	10	0	144.5	1.85	77980	2780	9.16	2868	64	696	40		184	10	0	1466	180	96900	3420	8.84	3856	64	696	40	
SPECIMENS CURED IN WATER																										
239	10	0	1495	-210	67400	2410							14	10	0	1500	-089	101000	3515						
284	10	0	149.7	023	79900	2840							59	10	0	1495	0.67	137000	4800						
329	10	0	1467	-213	62500	2225							104	10	0	151.7	-1.60	103300	3685						
374	10	0	1492	-1.13	73850	2580							149	10	0	147.5	-185	133500	4750						
419	10	0	149.1	-1.62	63850	2265	7.98	2464					194	10	0	1490	-115	109900	3870	1263	4124				

NOTE: The Per cent Weight Lost in Curing for Specimen 274 should read — 0.68.

TABLE II — RESULTS OF TESTS ON ATLAS PORTLAND CEMENT AFTER DIFFERENT PERIODS OF STORAGE IN A CLOSED 10-GAL. TIN CAN.

Tests were made in accordance with the Standard Specifications of the A. S. T. M. Each tensile result is the average for three or four briquettes, each compressive result for three 2-in. cubes.

Chemical analysis of fresh cement —CaO = 6[illegible].28, SiO₂ = 21.59; MgO = 2.52; Al₂O₃ + Fe₂O₃ = 9.[illegible]0; SO₃ = 2.0[illegible]. Loss on ignition = [illegible].47. Total = 9[illegible].65 per cent.

PHYSICAL PROPERTIES.

Age of cement when gaged with water.	Pats of steam tests on parts.	Residue on No. 200 mesh sieve. Per cent.	Time of set. Initial Hr.	Initial Min.	Final. Hr.	Final. Min.	Per cent water for Neat	Per cent water for 1:3 Mortar
Fresh	OK	22.5	1	51	[illegible]	[illegible]5	21.0	9.5
7 years	OK						21.0	10.0
10 years	OK	[illegible]3.6* 25.67†	3	30	6	[illegible]0	21.0	10.0

*Dried. †Without drying.

STRENGTH TESTS.

Age of cement when gaged with water.	Age after gaging with water Yr.	Mo.	Days.	Strength of mortars in lb. in.² Tensile Neat	Tensile 1:3	Compressive. Neat	Compressive. 1:3
Fresh		1	0	679	279	6,500	1,855
		2	0	723	312	8,800	2,075
		6	0	740	348	9,130	2,579
		9	0	711	314	8,875	2,850
	1	0	0	728	318	7,180	2,275
	1	6	0	858	305	7,621	2,540
	2	0	0	716	296	11,640	2,905
	4	0	0	618	258	8,994	2,968
	7	0	0	683	269	6,537	2,390
	10	9	0	613	249	6,974	2,734
7 years	0	0	1	583	....	2,420	.....
	0	0	1	567	188	5,410	898
	0		28	660	297	7,300	1,715
	0	0	60	675	320	6,710	2,075
	0	0	180	687	347	7,920	1,775
	0	0	360	665	329	9,980	3,720
10 years	0	0	1	412	.	2,885	.....
	0	0	3	....	177	.....	871
	0	0	7	537	22[illegible]	5,600	1,3[illegible]5
	0	0	28	603	327	7,195	2,005
	0	0	60	717	390	8,155	2,530

prior to testing; mortar specimens were tested immediately on removal from the water bath.

A spherical bearing was used in making all compression tests. The speed of the pulling head of the machine was between 0.05 and 0.10 in. per minute. Briquettes were tested in a Riehle Automatic Shot Briquette Tester.

Figure 1 shows strength-age curves for concrete subjected to the three curing conditions. Table I contains the results of concrete tests made at the 10-year period.

Some interesting data on the effect of long storage on the properties of portland cement are given in Table II. Figure 2 shows strength-age curves for the same data. Unfortunately the neat cement and mortar test pieces made of the fresh cement were not made by the operator who fabricated the remainder of the specimens. In as much as the latter operator was somewhat more experienced than the former, the early strengths of test pieces made by him are doubtless somewhat higher than they would have been if made by the earlier operator. At ages of one month or more discrepancies due to this cause should not be large, and a comparison of the results of tests on the fresh and stored cement for these ages is of much value. It should be noted, however, that during storage the cement was well protected from dampness by being enclosed in tightly covered 10-gal. milk cans.

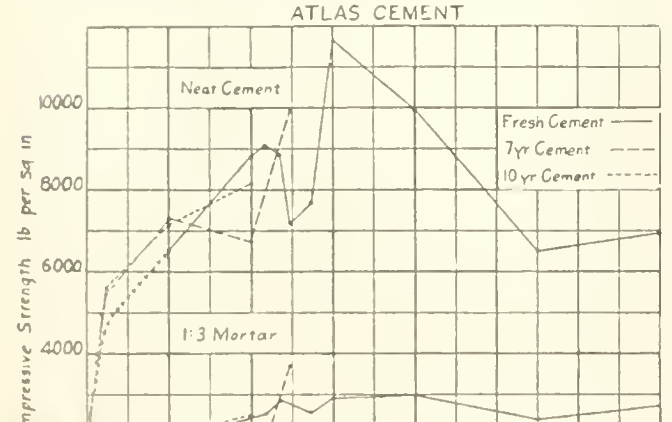


Fig 2.—Effect of Storage in Closed Milk Can on Strength of Atlas Portland Cement.

From the tests thus far completed it appears that the humidity of the surrounding medium in which portland cement concrete is cured exercises a marked effect upon its crushing strength. Concrete stored in a comparatively dry atmosphere, like the cellar storage, subsequent to a water curing for a couple of weeks, is not likely to increase in strength materially after it becomes a year old. Concrete stored in a more humid atmosphere, or under water, shows increasing strength with age over a much longer period of time. It is also much stronger than concrete subjected to a dry atmosphere. Considering strength at ages of one year or more, the concrete stored out of doors or under water had from 15 to 45 per cent greater strength than like material cured in the dry atmosphere of the cellar.

The tests on stored Atlas cement, together with tests on Universal cement subjected to somewhat similar storage conditions for two years* lead one to believe that standard portland cement may be kept without deterioration for several years, providing it is stored in tight tanks similar to the milk cans used for the Atlas, or the cylindrical galvanized iron grain bins which were used to store the Universal cement. It is interesting to note that the Atlas cement stored 10 years in this manner passed all standard requirements save fineness.

The First Annual Conference on Employment and Education

The conference of educators, employment managers, engineers, and experts in vocational and industrial education, held Nov. 12 at Chicago under the auspices of the American Association of Engineers, brought together a group of earnest seekers after the solution of the great problem of educating the man and then placing him in the right job. The spirit of the conference was largely one of co-operation, although it was evident that a greater unanimity of mind upon employment phases of the subject of the conference exists than on the primary question of education.

This first meeting on employment and education was not intended to accomplish more than to stimulate thought on the combined question and to set forth the importance of solving the problems of education and employment simultaneously. It brought about an exchange of ideas between educators, engineers in practice and employment managers. It brought forth two resolutions, which were adopted at the group meeting of representatives of educational institutions, of which one is exceedingly interesting in that it indicates that employment methods are already recognized as desirable in higher education. This resolution reads: "Resolved, that personnel work is necessary in engineering schools, and should be provided wherever possible." Probably no other thought was so well defined among those present as that there must be better selection of the wheat from the chaff in engineering education.

The other resolution reads: "Resolved, that it is the sense of the educational delegates that the best teachers in the schools, training engineers, should be placed in charge of the more elementary work." Both resolutions were introduced by Dean E. J. McCaustland of the University of Missouri.

The conference was not intended to concern itself entirely with engineering education, nor did it, but the presence of some engineers on the program gave an engineering flavor to the subject matter of the addresses.

---

*See "Permeability Tests of Gravel Concrete," Journal Western Soc. Engr., November, 1914, Vol. 19, page 814.

The engineering educators and the practicing engineers had a battle royal over the efficacy of a college education. Mr. R. O. Kramer, manager of the personnel department of Montgomery, Ward & Co., advocated the establishment of courses in management in the technical schools with a view to providing engineers with the preparation for their truest and best field of service; executive positions in the industrial and business world. Dean A. A. Potter of Purdue University, upheld the work of the engineering schools with the remarks that the technical world demanded a specialized product to a certain extent but that the aim of the schools was to give a broad fundamental training which would adapt the graduate-engineer to any field of work he might enter.

Mr. J. H. Libberton, of Chicago, manager of the service bureau of the Universal Portland Cement Co., urged that the student be started out right in college by first being interviewed by a vocational adviser. He disagreed with the statement regarding college activities made by E. Davenport in an article in The Saturday Evening Post for November 13 and urged the participation of the student in such activities to develop his initiative and imagination. He also recommended the securing of the best possible talent for teachers, who should be encouraged to engage in the practice of their profession.

"There are plenty of industries looking for the right kind of college men today," said Director A. B. Crawford of the Bureau of Appointments of Yale University. He explained in detail the methods of helping the undergraduate engineer to decide, first, what he wished to do and, second, what concern he wished to do it with.

Frank D. Chase, president of Frank D. Chase, Inc., of Chicago, spoke briefly of the qualities of loyalty, personality, experience and education which he uses as a basis for the selection of engineering employes. "It's a matter of common sense, which Professor Swain used to say should be called 'uncommon sense, it's so rare.' Engineering is merely the application of common sense to a specific field of human endeavor."

"Yesterday I was a mule-driver, today I am an electrician." Thus spoke a new recruit in the army school at Camp Dix recently. This is the spirit of the new army school, stated A. B. McDaniel, development specialist in construction for the U. S. Army. He explained the methods of training the soldier student to analyze, plan and execute a real job in some one of a hundred different vocations. The education in the permanent army will not only revolutionize the army and increase its efficiency, but have a great and lasting influence on the employment situation in this country.

John B. Densmore, director-general of the United States Employment Service, advocated a national clearance system of employment, operated very closely with the educational systems of the country. He deplored the present-day education by age instead of according to native ability and the lack of scientific methods of measuring abilities in the schools and colleges. A national clearance system would reduce the present duplication of expense of engaging men and women incurred by employers and the expense of finding positions for graduates incurred by educational institutions.

Professor A. W. Payne, of the department of trade and industrial education in the University of Minnesota, in speaking on "Vocational Analysis and the Engineer," said that "very few of our engineering colleges have as yet realized that most of their students eventually become administrators and executives, and in the vast majority of cases are managers in more or less degree." Inasmuch as the engineer is usually the only man in industry who has been scientifically trained in a scientific manner, the responsibilities of vocational analysis falls upon him. Mr. Payne outlined the methods of vocational analysis and determination of mental capacities. He strongly advocated a scientific selection of workers into proper vocations as a means of increasing prosperity and happiness.

Contracts of Fabricating Shops in October.—The records of the Bridge Builders & Structural Society, from reports collected by its secretary, show that during the month of October, 1920, 45,600 tons of fabricated structural steel were contracted for throughout the United States, equivalent to 25½ per cent of the entire capacity of the bridge and structural shops of the country.

Standard Forms for Bridge Inspection

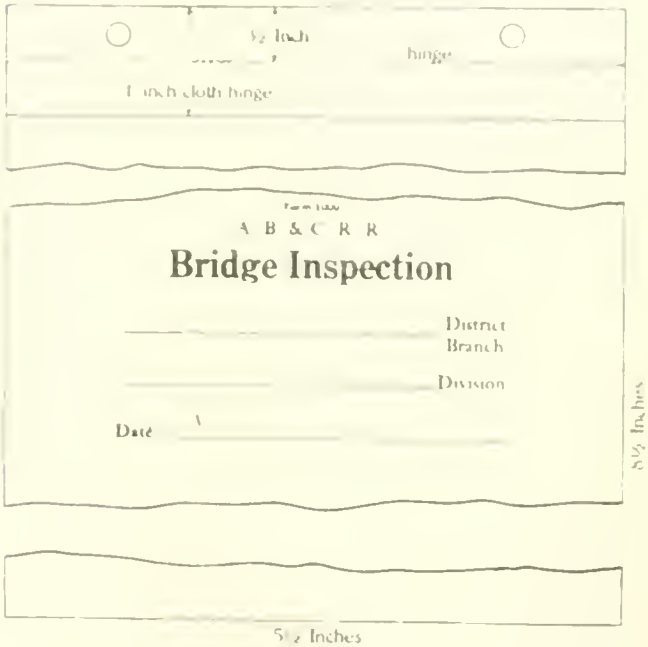
A suggested standard system for recording bridge inspections was submitted by a committee at the recent annual meeting of the American Railway Bridge and Building Association. In preparing the system the committee took into consideration the following requisites:

1. Facility in recording notes and saving the man in the field all unnecessary and onerous labor is a first requisite.

2. A diagram, sketch, or caricature of the structure to be inspected is a distinct necessity.

3. Provision for accurately recording conditions and findings which can be interpreted correctly in a review of the notes by anyone at any time subsequent to the inspection is essential.

4. Clarity of reference in the notes to any particular member so that the thought of the inspector cannot be misconstrued is of prime importance.



Form 1000—Outside Front Cover of Inspector's Book.

5. Utilization of the notes for maintaining correct office records of the consist of structures presents the best and most economical method known.

6. Provision for the compiling of field notes in a readily accessible form for subsequent use and future reference in the office is imperative.

7. A minimum of labor and expense must be involved in equipping the inspector with a concise and compact record of the consist of structures and findings of previous inspections.

8. The inspection is only the first step in the maintenance of structures, and the inspector's notes form the basis of the entire program of work. Forms, therefore, must facilitate the work of compiling bills of materials, making requisitions, and the issuance of shipping directions without error of confusion.

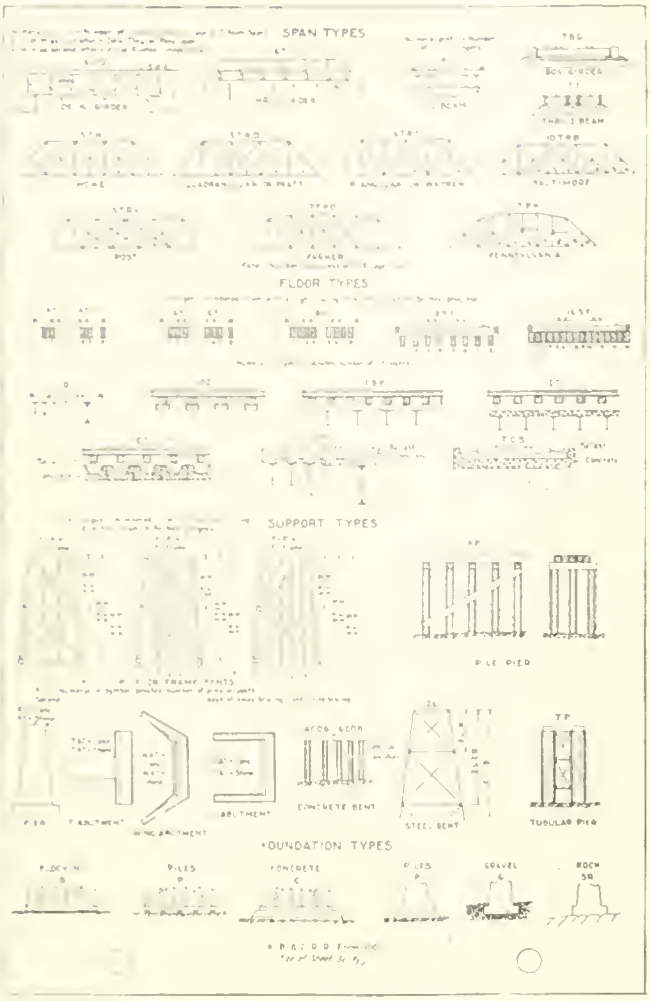
9. Any common standard proposed must be adaptable to all railroads regardless of mileage of form of operating organization, sufficiently comprehensive to cover all types of structures, and adequately elastic to permit of general or detailed expansion.

10. Simplicity and economy consistent with the end sought dictate that the number of forms be a minimum.

Under the proposed system all forms are to be printed on 5-in. x 8-in. cards, thin and flexible enough to be handled in a typewriter. The suggested forms are reproduced herewith.

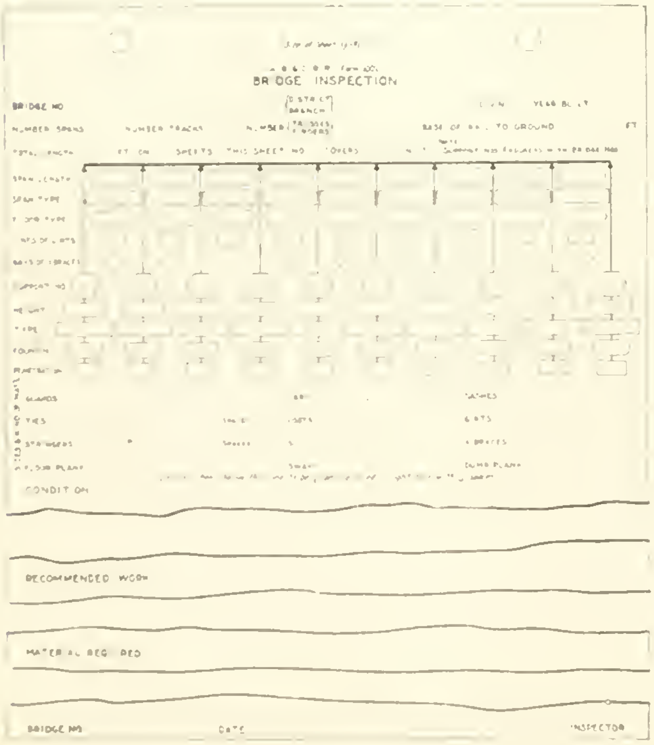
Form 1000 is the outside front cover of the inspector's book, made up for each district or branch in advance of the regular inspection.

Form 1001 is the key to structural types and kinds of construction with the symbols to be used in the designation



Form 1001—Key to Structural Types and Kinds of Construction with Symbols to Be Used in Designating Them.

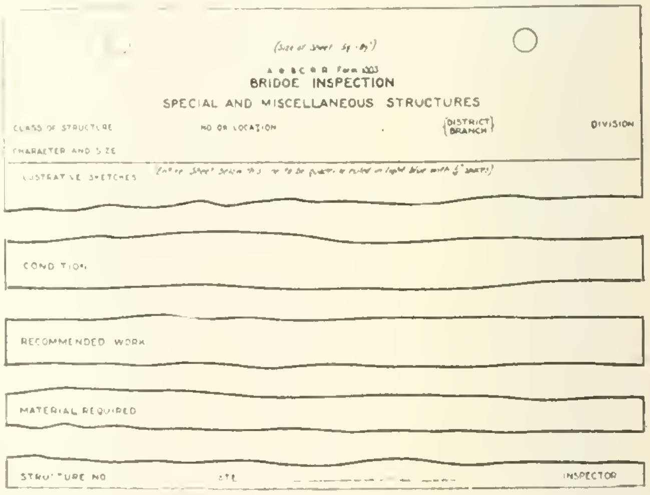
thereof. This should preferably be printed on the inside of the front cover in an inverted position so that when the book is opened it will be erect for instant reference. Owing to the very elementary scheme of symbols adopted, only one page of types will be required for each book. Hence this form need not be printed on the reverse side of the other forms as has been suggested. Moreover, the reverse side of the pages may be found convenient for the continuation of field notes, and should therefore be left blank. It is suggested that each railroad make a sheet of types and symbols to suit its particular needs. Only the idea is here illustrated.


BRIDGE INSPECTION
BRIDGE NO
DISTRICT BRANCH
YEAR BUILT
NUMBER SPANS
NUMBER TRACKS
BASE OF RAIL TO GROUND
FT
CONDITION
RECOMMENDED WORK
MATERIAL REQUIRED
BRIDGE NO
DATE
INSPECTOR

Form 1002—Central Form of Set. Carries Information as to Type or Make Up of Structure.

Form 1002 is the central form of the set. On this form, in as many sheets as necessary, should be entered all the required information as to type, consist or makeup of the structure taken from the office records. The information should preferably be entered on the form by a typewriter since the spacing of lines and symbols was arranged expressly for the purpose. The transcription of the data from the records to the form should be as complete as possible, not overlooking sizes and dimensions, for it is from this form, after the inspector has recorded his field notes thereon, that estimates and bills of materials are compiled and a working program arranged to carry out the inspector's recommendations without recourse to other sources of information. The form, when returned by the inspector, will serve to correct or verify the office record, and is to be made the basis for concurrently keeping up the history of the structure in all its details.

Form 1003 is for the inspection of those structures such as culverts, cattleguards, and buildings for which Form 1002 is not readily applicable, and the inspector's advance information accompanied by such illustrative sketches as may be necessary should be entered thereon. It is suggested that an entire sheet be devoted to even the smallest structure. The idea being that every bridge, culvert or other structure on the district should be covered by one or more pages of the book pertaining to that district.

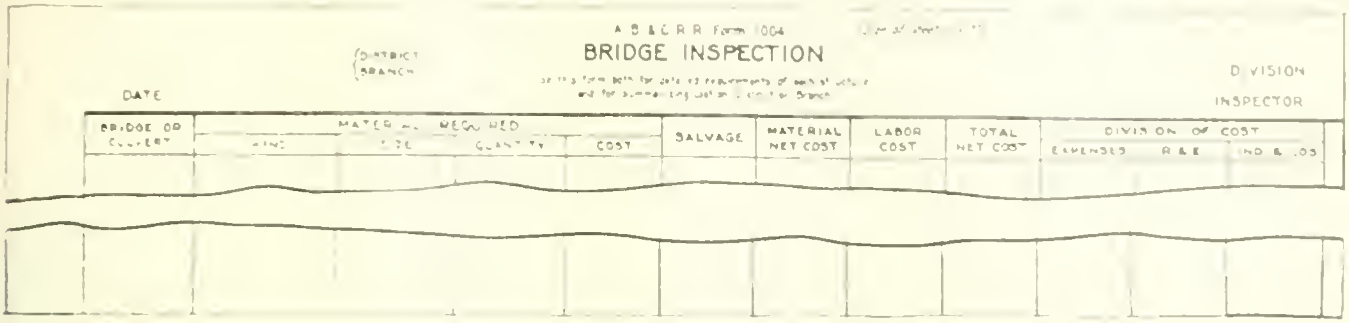

BRIDGE INSPECTION
SPECIAL AND MISCELLANEOUS STRUCTURES
CLASS OF STRUCTURE
NO OR LOCATION
DISTRICT BRANCH
DIVISION
CHARACTER AND SIZE
ILLUSTRATIVE SKETCHES
CONDITION
RECOMMENDED WORK
MATERIAL REQUIRED
STRUCTURE NO
INSPECTOR

Form 1003—Used for Inspection of Special and Miscellaneous Structures for Which Form 1002 Is Not Readily Applicable.

After the data for any one district or branch have been transscribed from the records to Forms 1002 and 1003, the sheets covering the various structures are to be arranged in geographical order and bound together by removable fasteners, such as "Chicago Screws" or "McGill Fasteners," using Form 1000 as a front cover, Form 1001 as a front flyleaf if it is not printed on the inside of front cover, and a half-page length of medium weight tag board for a back. The inspector is to be furnished with a stiff covered portfolio of sufficient capacity to accommodate the thickest built-up book and provided with a pocket next to the back cover into which is inserted the short tag board back of the booklet. The inspection of a district or branch results immediately in a self-contained book of field notes without surplus pages and ready for the compilation of estimates and bills of material, for the correction of office records, or for such disposition as the practice of the particular railroad may dictate. It is to be observed that the inspector should be supplied with extra copies of the forms in the event that conditions are found necessitating the insertion of additional pages in proper geographical order.

No set of printed instructions to inspectors is recommended, the thought being that each railroad should handle this feature to suit its individual requirements. In any event, such instructions must be considered as a matter separate and distinct from the forms. We think, however, that if printed instructions are issued they could with advantage be printed in form and size for mounting on the inside of the front portfolio cover.

Form 1004 is designed for use in reporting both detailed and summarized results of the inspection. No suggestion is made as to the movement of this form for the reason that practice and kind of operating organization will doubtless govern the disposition of the inspection report.



Form 1004—Used for Reporting Both Detailed and Summarized Results of Inspection.

The Trend of Specialization*

By WILLIAM E. VOGELBACK,

of the Sanderson & Porter Engineering Staff

The study of industry is a study of organization. After many years of systematic grouping and arrangement of activities we find business emerging in the last decade as one of the major professions subdivided into a multitude of minor professions. Each of these minor professions, such as advertising, credit, management and salesmanship, have become highly specialized sciences. Other major professions, particularly engineering, have followed this same trend of specialization. A century ago a man in any branch of the engineering profession was identified simply as an engineer. Fifty years ago he was a civil or mechanical or electrical engineer, while today these latter terms give but a vague idea of his qualifications or his occupation. Specialization finds its way into all industries and professions, subdividing single occupations into many, and confining the individual more and more to specific tasks. Men have learned to anticipate the trend of events, and, therefore, we find a profession, as engineering, for example, crowded with men of but limited training, and capable of but minor specific tasks.

There is an evil here to the detriment of the individual as well as to the profession. As it is, the world needs men of vision—men who are capable of big things—men who are scientists. Comparatively few men are scientists in the broader application of this term. Few man are possessed of the ability to analyze complete problems, to see the relation between the problem in its entirety, and any or all of its component factors. The individual minds of the great majority work synthetically. They grasp only that particular phase of a problem which comes under their immediate observation; one factor at a time without regard for the relation of that factor to the sum-total.

Specialization does not assist in turning out these scientists—these leaders of men, but, on the contrary, materially assists in their suppression, and hence we must look eleswhere for the forces which tend to preserve this balance.

These forces will be found in our educational institutions, and our professional societies. Here, stringent requirements should be fulfilled and ethical standards should be maintained. But of these two, the greater responsibility rests upon our educational institutions. The measure of proficiency of a college is not what studies are embodied in its curriculum, but what the average student learns, which will be of advantage to him in the years which are to follow.

In the short space of the usual college course today it is not expected that colleges will turn out men fully equipped for their professional practice. The aim should rather be to inculcate a method of logical reasoning; to turn out analytical thinkers—scientists. But I feel sure that you will agree with me, that too many men just out of college come better equipped with a collection of facts than with methods of analysis. In other words, we are turning out synthetical thinkers—men whose measure of comprehension of a subject is the quantity of facts they possess. I desire to emphasize this distinction between analytical and synthetical thinkers. Every individual belongs to one or the other of these classes. The class of synthetical thinkers comprises the rank and file, the detail worker; the narrow specialists. The class of analytical thinkers, comprises the executives, the leaders, the planners, men of vision and foresight.

The degree of our analysis of any subject depends upon the interest we have in it. And our interest will depend upon our comprehension of the subject as a whole. If we reflect back upon those subjects in which we were most proficient in school, we will find that they were the ones in which we had the greatest interest. And probably we all recall our attitude toward those subjects which we then seemingly knew we would never have occasion to put to practical use. Interest in a subject is more easily obtained by a preliminary survey of the subject to be studied.

Take our large cities, centers of industry with their vast day and night educational opportunities. Would it not appear that the great majority of our successful men should be those brought up under these educational advantages? And yet as we run through the pages of "Who's Who" we observe in page after page the names of men whose education was acquired in the village school house, or small town college or by home study. I believe these incidents are relevant and important, and that they are a natural result of a well defined cause. This cause is the greater ratio of practical learning to the degree of specialization. In the smaller towns, industry is centralized and extensive specialization is not expedient. Here the young man entering business sees the small shoe manufacturing industry or the rice industry in its entirety. He sees the relation between the different departments and the whole plant. With the whole mechanism under one roof, so to speak, his view is comprehensive. This is impossible in the industries of our larger cities. Here, specialization has reduced the work of the individual to a mere routine. He fails to see the relation of his job to the industry. In time perhaps he will have held many jobs, but he will always be working under the disadvantage of lack of comprehension.

After a man has completed his college training, the evil effects of specialization as applied to him, must be stemmed by the professional organizations. Here by his association with other men in the same general profession, he extends his interests into broader fields. Perhaps the most beneficial work that can be done by a professional society is that of maintaining appropriate standards of ethics and qualifications for membership. Here, too, is charged a large share of activity in securing appropriate license legislation. Limited preparation for the professions should be discouraged.

The big problem of today is how are we going to keep the synthetical class from growing greater in proportion to the analytical class. We see how specialization tends to confine more and more the individual to routine duties; to make of him a mere cog in the great wheel of industry. The remedy calls for a greater interest in our undertakings. The larger business institutions have come to regard this interest from the standpoint of the individual's partnership in the business. They have evolved the medium of employes' organizations and house organs for educational purposes. In this way they have been able to maintain a partial balance between specialization and training.

In the profession of engineering the individuals must have recourse to their professional societies and we find such organizations as this American Association of Engineers fulfilling an urgent demand, and materially assisting in preserving the balance. Nevertheless this profession is crowded with men who have spent but a few months in some school, preparing themselves for the position of estimators, computers, draftsmen, etc., and yet with this limited training assume the professional title of engineer. This accounts in a large degree for the growing disparity of remuneration between engineering and other professions or occupations.

---

*Address before the Conference on Employment and Vocational Education, Congress Hotel, Chicago, Nov. 12.

There is but little activity in the world that does not require engineering. Next to law, engineering should find a leading place in national government, but not until our educational institutions, our professional societies, and our individuals recognize and control this trend of specialization, instead of being controlled by it, will engineering find its place and proper standing, and attain its leadership in world affairs in general.

Railway Experiences in Spray Painting

Experiences of several railways in painting by spraying with air pressure were outlined in a committe report submitted last month at the annual meeting of the American Railway Bridge and Building Association. The notes following are abstracted from the report.

The Kansas City Southern Ry. used the spray for painting bridges, the interior and exterior of depots and many other buildings, excepting train work. The results obtained are in proportion to the expertness of the operator. They use 60 to 80 lb. of air by the aid of a portable outfit and claim a good quality of work with a considerable saving of cost, and are enabled to get along with less scaffolding and staging than is used for brush work. Ladders can be used for high work by raising the tank underneath with light block and tackle. The results are generally satisfactory.

While the Boston & Albany R. R. has used the spray painting apparatus only about six months on bridge work the supervisor of bridges and buildings seems to think there are no limitations to the practical uses of the method. He recommends the spray for whitewashing, painting large surfaces and in reaching inaccessible places, and the brush for lattice work, trimming, etc., and for touching up any poorly applied spray painting.

The bridge and building department of the Baltimore & Ohio R. R. has used the paint spray for about 20 years. It has found that the best results are obtained with the use of small portable outfits with 85 to 90 lb. pressure, on bridges, buildings, fences and freight cars. It is best adapted to rough work where a large surface is to be covered with a cheap or medium grade of paint and a fairly good job can be made without brushing. On smooth surfaces where the best finish is desired it is best to follow up with hand brushing. On ordinary work where it is not necessary to follow up with the brush there is a saving of labor of 65 per cent with an increase of materials of only about 10 per cent. They do not recommend its use for lattice work or where there is considerable trim work. Some bubbles are formed where smooth surfaces are covered and these must be brushed out. It is necessary to protect workmen from inhaling the fumes and this can be accomplished by the use of a dust or gas mask or a wet sponge. They use their own sprayers.

The Southern Ry. has been using portable outfits for various kinds of work with air pressure of 60 to 80 lb., working from ladders, staging or scaffolding, with piping and hose for bridge work, and hose only for building work. Trimming work is done by the aid of a light metal shield held in the hand of the operator.

This road reports that there is very little work that cannot be successfully done with the machine, but until the operator becomes expert it is probably best to apply paint on lattice work and trimming with the brush. One man with the machine can do the work of three with the brush and with much less exertion. The expense of labor is reduced 75 per cent. The work can be done successfully with ladders, staging and such apparatus as is generally used for brush work. No trouble has been experienced with air bubbles if the paint is properly mixed and the apparatus properly adjusted.

The Southern Pacific Ry. uses the spray for applying paint to bridges and buildings as well as for freight cars and other equipment and finds that in the hands of an experienced operator it can be used for all purposes except on trim work with very satisfactory results as compared with brush work, and with the loss of very little paint and a great saving of labor. One outfit uses an air pressure of 50 lb., while another uses as low as 12 lb. at the nozzle. No bad results are experienced from air bubbles. Masks are sometimes used by the operator, but more often not. The spray reaches inaccessible parts much better than the brush.

Safety Methods of a Large Construction Co.*

By J. H. SCHULTS,

Safety Engineer, James Stewart & Co., Inc., New York City.

The James Stewart Co. actually started in on safety work in Pittsburgh some 15 or 16 years ago, but it was not until four or five years later that we decided to push this on our work throughout the country. Of course at that time the safety movement had not reached the point where we could procure bulletins, literature, etc., to facilitate same, so that it necessitated making up our propaganda, so to speak, as our experience suggested.

We had printed, in five or six languages, circulars giving safety suggestions, which were handed to each man on his employement; notices and slogans on the back of pay envelopes; oilcloth and enameled signs to be posted around the job; circulars to superintendents and also to foremen for their attention and guidance. As is usually the case with new methods, it was a little difficult to secure the earnest support and co-operation of the construction forces, and it required constant efforts on the part of the main office to try to get the superintendents and foremen to see the humanitarian as well as economical value that the prevention of accidents would have on the work.

As many of you can no doubt appreciate, there were then superintendents of the old school whose only thought was to get the work done, and accept the fact of injured men and consequent loss of their services to the job as part of the natural hazard of construction work, and let it go at that. It was here that we had our hardest problem of converting them to this idea, and the conversion was not done by the heroic method of firing them, as good superintendents are only developed by long training to our methods, and do not, even to this date, grow on bushes. These same remarks, of course, would apply to the foremen, and in order to secure the necessary interest we started the following:

Foremen's Accident Record.—Copies of accident reports covering our work throughout the United States and Canada are sent to our main office with a slip showing the name of foreman in charge at time of accident. We might add here that instructions are to report every accident, no matter how trivial, and that every man injured be sent to a doctor for treatment. These accidents are tabulated each month, and a memorandum sent to each job showing the number of accidents as charged to each foreman, and where any one class of injury shows a large frequency or an increase as compared with the month previous, an explanation is asked for from the superintendent, together with plans for the reduction of such accidents. We then follow this up with letters to the jobs to the effect that a foreman's value to the company depends as much on his accident record as on the work performed.

This, of course, has its effect in two ways, the more important one being that it brings right up to the foreman's attention how his record stands on accidents as compared to the other foremen, and brings a competitive spirit into the matter, as well as the undoubted moral effect that a certain number of men had been injured while under their control—another factor in arousing interest.

As the question of "Safety First" spread and our construction forces realized the importance to the work through the conservation of men, new problems arose and the following will serve as an illustration:

We had a contract for work on the New York State Barge Canal, covering a length of approximately 60 miles and operated a number of dredges, drill boats, tugs, scows, etc., which presented the hazard of drowning, and although protective railings, life lines, etc., were installed, drownings occurred which could not be prevented by protective devices or safety instruction, the victims almost wholly being the common laborers, usually foreigners.

---

*Paper presented at the 9th Annual Safety Council, Sept. 27-Oct. 1, Milwaukee.

We then decided that a solution of this matter might be effected by segregating the swimmers from the nonswimmers, and using the former men on the water work. After making a canvass of the employes, we came upon a peculiar situation, namely, that the majority of men working on the shore could swim, and those working on the water could not. We then started to switch the men around as much as possible, and in addition had some of our foremen, who were adept swimmers, start a swimming school.

It can realized here that "Safety first" meant something real tangible to each man, and not much urging was required to have the men take up swimming, as knowledge might mean the difference between life and death. Between the two, we finally reached the point where drownings practically ceased. I might incidentally add, based on the foremen's reports, that the swimming lessons were also beneficial from a health standpoint.

Job Safety Committees.—We also commenced the inauguration on each job of a safety committee, composed of the superintendent as permanent chairman, and foremen of each trade as members and representatives of subcontractors. The duties of the committee are to go around on the job from time to time and observe that general safety practices are being followed out, and meetings held every two weeks on a regularly appointed day, when suggestions are brought up and discussed and if of value, the suggestions are transmitted in writing to the foreman affected. Regular minutes are kept of each meeting, copies being sent to the main office for information, suggestion, and generally to keep in touch with the safety situation, and, where suggestions of value are brought up, transmitted to our other work. Where the size of the work permits, different foremen are rotated from meeting to meeting, in order to obviate the possibility of their falling into a rut, and at each meeting reports are made on the suggestions that were ordered to be carried out at the previous meeting. To illustrate the form of minutes as kept by our jobs, we give below a copy of a typical report.

Carpenter foreman and steward were instructed to inform all men to be sure and see that scaffolds are safe before they start to work on them.

Guard for saw received today and is being put on.

Foreman Lindquist was instructed to clean concrete off ladders, also to be careful in cleaning out chute and try to avoid dropping water on men below.

Foreman Al. Ainsley was instructed to put one man on turning down nails.

All foremen were instructed to warn new men regarding accidents, and, as soon as they have one, the office is the place to report same.

Goggles should be used by all men chipping, working in cement bins, and stripping that requires them to look up in the air.

Carpenter foreman was instructed that whenever building ladders in the future rungs should be set in.

All bolts sticking out of floor after being concreted should be cut off by ironworkers.

Trade Stewards on Safety Committees.—Just as a sidelight, I might add here that only recently one of our superintendents wrote in that he had put the stewards of several of the trades on the safety committee, and they had told him that this was the first time in all their experience on construction work that they had a safety committee in operation, and were impressed with its value. Apparently they were sold to safety right then and there, as in following up the succeeding minutes on this job I noticed they are giving talks to members of their union on safety, as well as making suggestions of value from a safety standpoint at the committee meetings.

This keeping of minutes, we have found, gives a very good index of what interest is displayed toward "Safety first," and is considered by us as one of the principal features in this work. In addition, suggestion boxes are put up on the work for the use of the men, and where any suggestions are found to be of merit they are put into operation and the man making the suggestion is given credit by posting his name and the particulars on the bulletin board. Here again we secure the interest of men through this feature.

A bulletin board is in use on all jobs, and as bulletins are received from the national council they are posted thereon, together with such local notices as job offices may deem pertinent to the work. The board is of a size sufficient to carry eight of the small-sized council bulletins and covered with glass to protect from the weather as well as from the men also, as we have found on some jobs the men object to bulletins depicting what might be termed the gruesome results of an accident, but in our judgment this is more than compensated in the doubtless vivid impression that the men retain of what should be avoided in the prevention of accidents.

The foregoing is given to show the progression of methods pursued by our company in furthering the cause of safety. We require our jobs to adhere as strictly as possible to the above, varying it only where the best interests of the job and safety may deem it necessary in the superintendent's judgment, but in general this is the practice as followed by our various jobs.

Tests of Sound-Proofing Qualities of Metal Lath Partitions

The Associated Metal Lath Manufacturers, Inc., realizing that there has never been a thorough knowledge of the sound proofing qualities of metal lath partitions (particularly solid partitions), several years ago induced Professor F. R. Watson of the University of Illinois to start an investigation on this subject. He started his investigations in November, 1918. Many months were spent in perfecting instruments which would positively measure the various amounts of sound which came through the walls. The Rayleigh Resonator, adjusted to a sensitivity calculated to be capable of measuring the minuteness of the sound transmitted through various partitions, was the instrument finally adopted. The results of the tests are summarized in a recent issue of General Fireproofing, from which the matter in this article is taken.

The experiments were conducted in two basement rooms separated by two isolated 9-in. brick walls, the ceilings and floors being of concrete. The double wall between the rooms was cut through and the plaster partition under test was built in this space solidly. In order to keep the sound absolutely constant, a modified organ pipe was especially designed for the test. It was adjusted to give a pitch of one octave above middle C, and was blown by air from a standard pressure tank. This sound is of the average quality and pitch usually found in habited buildings. The mouth of the organ pipe was located at the focus of a reflector, so that practically all of the sound was directed toward the partition under test and the reflected sound absorbed in padding. In this way, an effect was obtained similar to that resulting from a searchlight.

The Rayleigh Resonator was carefully adjusted to measure the intensity of sound vibrations. This work was so intricate, and involved so many different experiments that it required about two years from the first study of the problem to perfect the appartus and complete the test.

Four distinct tests were successfully carried to completion—comparative measurements on the amount of sound passing through partitions of successive thicknesses of plaster-covering and of the following constructions:

1. So-called "hollow block partition" plastered on both sides.
2. Same blocks with all holes filled with the same material out of which the blocks were made.
3. Solid plaster partition on metal lath.
4. Solid plaster partition with plaster board core.

The first two tests proved the greater efficiency of solid partitions over those with hollow bridged spaces. The last two tests considered two types of solid partitions, one with a metal lath core and the other with a plaster board core. Both partitions were tested after plaster coats had been successively applied till the thicknes of each partition was 2 in. The results of this comparative test showed the following:

Solid metal lath and plaster partition—relative intensity of transmitted sound 0.93.

Plaster board and plaster partition—relative intensity of transmitted sound 2.33.

For many years it has been customary to make solid metal lath partition 2 in. thick. There was no scientific or theoretical structural reason for this thickness—it was the result of practical experience. One purpose of the test was, therefore, to determine scientifically the minimum thickness of plaster partitions at which soundproof efficiency was reached. This was determined by starting the readings of the transmission of sound with the thinnest layer of plaster possible to lay on the metal lath and plaster board which constituted the respective cores of the two types of partition used for this particular test. The plaster was put on in successive coats until a total thickness of 2½ in. was reached for each of the partitions.

At about 2 in. in thickness it was apparent that the metal lath partition had fully developed the efficiency of the plaster. The plaster board partition, on the other hand, at 2½ in. thick did not show as effective sound insulation as the metal lath partition at 1⅝ in.

The readings indicate that sufficient sound-deadening qualities are had with a plaster partition with metal lath core at a thickness of 1½ in. The full efficiency of the plaster is had at 2 in., and for structural reasons, particularly on long and high partitions, it would seem desirable to maintain the 2in. thickness as standard.

Concrete Bridge Construction in Winter Months

By enclosing the entire work in a tent a concrete bridge over the Little Goose River in Sheridan county, Wyoming, was constructed during the winter months. The bridge has three clear spans of 37 ft. each The work is described in Concrete in Architecture and Engineering.

Weather conditions last winter in that part of the country were the most severe encountered in many years, but because the highway, of which this bridge formed a link, is a very important one, the State Highway Department saw the need of completing the bridge so that the road between Sheridan and Dietz might be opened early in 1920 for the heavy farm hauling prevailing in that section.

Bridge Site Enclosed in a Tent.

Construction work was started in the fall of 1919, and forms for the three spans erected. Before any concrete was placed a large tent was set up over the entire structure site and fires kept going in the enclosure in stoves with smoke outlets through the top of the tent. Aggregates and mixing water were heated. During the progress of the work a snowstorm, followed by severe cold lasting several days, tested the effectiveness of the tent. The housing proved equal to the emergency, however, and there was no particular difficulty in keeping the enclosure sufficiently warm until the concrete had hardened.

The work on this bridge suggests the application of the same principles to longer structures where it might be practicable to house in only one or two spans at a time. The same method could be applied to the construction of long walls and other relatively narrow structures by housing in successive short sections.

Union Label on Building Plans.—Following a demand of the Building Trades Council of Newark, N. J., made about the middle of October, that all plans for buildings and structures made in Newark must be drawn by the members of the Engineers', Architects' and Draftsmen's Union, steps to negative this attempt to force engineers to unionize were inaugurated by the American Association of Engineers and by the New Jersey Chapter of the American Institute of Architects. The demand of the unions was to the effect that after Nov. 1, 1920, union labor, composing the Building Trades Council of Newark, would do no work on new buildings or other structures for which the plans were not made by union draftsmen or engineers. In commenting on this situation in a letter published in the Newark Call of Oct. 21, Mr. C. E Drayer, secretary of the American Association of Engineers, said, "The question of trade unionism in the engineering profession has been carefully considered by the American Association of Engineers and the action taken at the annual convention last May, pronouncing the advocacy of trade union methods by a member as cause for expulsion, would leave no room for doubt." Draftsmen in the architect offices in Newark have been canvassed on the question of union affiliation and almost to a man they are opposed to any unionization of draftsmen, engineers or architects. The General Contractors' Association of Newark will continue to use plans made by non-union architects and draftsmen. James O. Betelle, president of the New Jersey Chapter of the American Institute of Architects, is working in harmony with the American Association of Engineers on this matter.

Building Operations in October.—Prolongation of the period of business uncertainty caused a slump in building operations in October, according to statistics compiled by the F. W. Dodge Co. Contracts awarded during October in the 25 states comprising the northeastern quarter of the country amounted to $177,791,000, which was $28,000,000 less than the September figure. The decline was general throughout the territory, except in the Northwestern States, Minnesota and North and South Dakota, which showed an increase over September. In spite of the relative inactivity of recent months, the total amount of money involved in building operations during the first ten months of this year has amounted to 10 per cent more than the amount for the same period last year.

Personals

Paul J. D. Mundy of Clifton Forge, Va., has been appointed city manager of Radford, Va.

U. Stephens, formerly resident bridge engineer for Runnels County, Texas, has been appointed county engineer for the same county, succeeding J. L. Dellis, resigned.

W. H. Corddry of the Harrisburg office of Gannett, Seelye & Fleming, Inc., engineers, has been placed in charge of the Memphis office, 262 Randolph Bldg., of that company.

John Ihlder, managing director of the Philadelphia Housing Association, has been appointed manager of the new civic development department of the Chamber of Commerce of the United States.

James Gamble Rogers of New York has been appointed consulting architect for Yale University. Mr. Rogers, a member of the class of 1889, was architect of the Harkness Memorial quadrangle, now nearing completion at Yale, and the new United States postoffice at New Haven, Conn.

James C. Cronin has been appointed chairman and Fred J. Hartman secretary of a committee which is drafting a building code for Pennsylvania. Mr. Cronin and Mr. Hartman are representatives of the State Industrial Board. The other members of the committee are D. Knickerbocker Boyd, Edwin Clark, Philadelphia; S. A. Dies, Professor C. G. Dunnells, Pittsburgh; C. T. Ingham, representing state chamber of commerce; John Molitor, chief bureau of housing, State Department of Health; Bernard F. O'Rourke, Wilkes-Barre; Edgar A. Weimer, Lebanon; E. F. Welsh and C. H. Dancort, Pittsburgh.

A. E. Foreman has been appointed district engineer of the Portland Cement Association and will have charge of the newly opened Canadian office at 718 Granville St., Vancouver, B. C. Mr. Foreman was graduated from McGill University in 1903. After a year's travel and several years spent in accumulating general business experience, he formed a connection with the Concrete Engineering & Construction Co. of Vancouver, of which firm he was secretary and general manager from 1907 to 1909. For a year following, he was a member of the firm of Dutcher & Foreman, consulting engineers of Vancouver. Since 1910 he has had various engineering connections, among which are the following: Resident engineer in charge of construction of hydroelectric power development at Revelstoke, B. C.; supervising engineer on special harbor work for Victoria, B. C.; assistant city engineer, Victoria, B. C. At the present time he is president of the Canadian Good Roads Association.

Industrial Notes

The Chicago Pneumatic Tool Co. announces the removal of its rock drill plant from 864 East 72nd St., Cleveland, O., to the company's Boyer pneumatic hammer plant at 1301 Second Blvd., Detroit, Mich. Location of the company's Little Giant air drill plant at 1241 East 49th St., Cleveland, remains unchanged.

Obituaries

John G. Schilinger, division engineer for the Rutland railroad for 10 years, and 20 years previous to that division engineer for the New York Central, died Nov. 14 at Burlington, Vt., of cerebral hemorrhage.

Henry Wood, a pioneer in Arkansas railroad development, and the builder of several railroads in that state, died at his home in Philadelphia, Pa., Nov 16. Mr. Wood formerly was general manager of the Fort Smith and the valley divisions of the Missouri Pacific R R. He constructed the old Choctaw, Memphis & Gulf R. R., from South McAlester, Okla., to Little Rock. After this line was purchased by the Rock Island he built the Midland Valley R. R.

L. H. Peabody, civil engineer in the bridge department of the Rhode Island State Highway Department, died Nov. 16, aged 42. After graduating from Brown University in 1903 he became connected with the firm of O. Perry Sarle. Later he went to the Southern Ry., returning in 1916 to take a position with the state highway department in its bridge division. He remained with the highway department about one year, until January, 1917, when he went to New York to work for the firm of Ford, Bacon & Davis, which sent him to Pittsburgh and other cities to do engineering work. In November, 1919, Mr. Peabody came back to Providence and again became connected with the state highway department, retaining that position until his death.

Roads and Streets Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 413 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.
Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., DECEMBER 1, 1920. Number 22.

Causes of Construction Stagnation in 1920 and the Prospect for 1921

The year 1920 opened with bright prospects for a revival of construction but, all in all, it has been disappointing. It was correctly reasoned that the four years of war had served to curtail construction to such an extent that an era of extensive construction would follow; but foresight was not keen enough to disclose what would happen in 1920 to delay the arrival of the big construction era.

The general expansion of business produced such a strain upon the railways that, even had there been no strikes and no shortage of coal, it may be doubted whether enough cars would have been available to meet the demands for construction purposes. Our railway systems had been financially starved for 10 years prior to the war, and this was the basic reason for their inability to meet a moderate increase in the demand for cars.

Strikes of switchmen at many big railway centers and of stevedores at ocean shipping points caused freight congestions that made an already inadequate supply of cars even more inadequate. Car-mileage per day fell to an exceedingly low mark.

The climax of trouble was reached, however, when the end of the bituminous coal strike occurred, for then it was realized that many industrial plants would close down unless nearly all open top cars were used to carry coal. On June 2 the first priority car order was issued, and this immediately tied up a great deal of construction work. The last priority order was issued Oct. 8, so it was not till the close of October that open top cars began to be available in larger numbers for the carrying of sand, gravel, stone, etc. Even then the high price of coal, and the opportunity for large profits not only for coal producers and dealers but for the carriers, led to an abnormal use of open top cars for coal carrying.

In addition to a shortage of cars there was a shortage of common labor. With factories running overtime and paying very high wages, there was an unusual demand for labor. Common labor had been recruited in large numbers every year from the immigrant class, but immigration had almost ceased during the war, and had barely begun to return to normal early this year. Hence construction labor was scarce, but it was also less efficient, because abnormal demand for workers creates in them, on the average, feeling of disinclination to give a day's work for a day's pay.

At the first sign of a revival of construction last spring, the prices of many kinds of construction materials rose inordinately. This, coupled with the inefficiency of labor and the difficulty of securing materials, put a check upon construction.

Inability to sell bonds or other mortgages at low interest yields was another important factor in retarding construction work. Many states, counties and cities have clung stubbornly to the idea that they should not pay more than 4.5 to 5 per cent interest on borrowed money. But there is at last a dawning realization that interest rates are likely to be high for many years. It was not till 8 years after the civil war ended that bond interest yields began to fall. To reasons given in our issue of Sept. 22 we may add the following reason why interest rates will remain high for several years:

Prior to the world war the total outstanding issues of tax exempt bonds (federal, state, county and city) amounted to less than $6,000,000,000, whereas now the total is $11,000,000,000. This enormous increase in tax exempt securities has absorbed so much capital that the demand for other classes of bonds has been proportionately reduced, with consequent fall in their prices and rise in their yields. Moreover, through the loading up of investors with bonds of this class, there has resulted a slackened demand for new issues of public bonds. At the same time high income taxes have reduced the amounts annually available for investment in bonds of any character.

In an era of falling prices, producers of commodities and merchants who have stocked up are reluctant to sell, hoping that prices will rise again. In order to hold their commodities for better prices, most of them are compelled to borrow money. This is well exemplified now in the case of farmers. But a general borrowing of money for this purpose may not merely keep the already high interest rates high but send them even to higher levels.

Taken in connection with the causes given in our issue of Sept. 22, these additional causes are likely to have much the same effect upon interest rates as was witnessed in the years 1867 to 1873, when interest rates rose slowly but steadily. Bond salesmen are telling the public that bond interest yields always drop (and therefore bond prices rise) when commodity prices drop. But this generalization is not true, as economic history abundantly proves. The "curve" of bond yields follows the general trend of the curve of commodity prices, but it lags behind in its swings, often being several years behind.

Having reviewed the courses of construction stagnation during 1920, we are better able to forecast what may be expected in 1921. We see that lack of cars, strikes and inefficiency of labor are not likely to confront us next year in the construction field. We see that while high interest rates will continue, there is a rapidly growing conviction that no relief from that element of cost can be looked for, and that consequently it will not pay to postpone construction in the hope of a substantial decrease in interest rates in the near future.

Labor will again be plentiful and efficient, but it will probably remain high priced, especially in the construction field. Labor unions strenuously resist wage reductions. The greater use of labor saving devices will probably be the only way of securing a marked decrease in the labor cost of construction.

As shown in last week's issue, labor, coal and freight form so large a part of the cost of construction materials that a large reduction in the prices of such materials below the level of the 1919 prices is not likely to occur. Here again the history of actual price changes following our Civil War may be studied with profit. We commend to our readers a careful study of that history as given in our last week's issue.

The A. M. Soc. C. E. Refuses to Join the Federation

The proposal that the American Society of Civil Engineers enter the Federated Engineering Societies has been defeated. There were 5,608 votes cast, of which 3,328 were against and 2,380 in favor of the proposal.

The result is what we had foreseen, but for reasons given editorially in our issue of Nov. 3, it is a regrettable decision. Fortunately, the decision is not irrevocable. Many of the opponents of the proposal to join the Federation have expressed the opinion that the Am. Soc. C. E. will ultimately join the Federation. There appears to be considerable opposition to the men most active in the Federation, and it is not unlikely that this personal opposition is at the bottom of the decision of many civil engineers to vote against the proposal. Moreover, there are many civil engineers who are members both of the Am. Soc. C. E. and the Am. Assoc. of Engrs. Members of the latter society (A. A. E.) are, as a rule, opposed to the Federation, believing that it will merely duplicate the work of the A. A. E. Consequently it is probable that many adverse votes on the proposal before the A. S. C. E. came from members of the A. A. E.

It is our opinion that there is so much work to be done along the lines proposed by both the A. A. E. and the Federation that there is need of both these organizations. Moreover, the highest degree of efficiency is often attained where there are two competing organizations.

There is no doubt whatever that the A. A. E. has aroused all the older engineering societies to activities that either did not exist at all, or were negligible in their effect. But it should not be overlooked that many engineers will not join two engineering societies, and that, therefore, there would remain unutilized great potential energy were no such organization as the Federated American Engineering Societies in existence.

One of our subscribers has protested against our editorial support of the Federation, stating that we seemed to be discriminating against the A. A. E. We have favored both the A. A. E. and the Federation, for both are committed to programs that have our hearty support. Indeed it will be found by reading our editorial pages as far back as 1906 that we advocated essentially what these two organizations stand for. The very fact that the above mentioned subscriber has resigned from the A. S. C. E. illustrates our contention that there is need of the Federation; for it shows that there are men who will not pay dues in two engineering societies. For every civil engineer who will give up his membership in the A. S. C. T. to join the A. A. E. there are probably 10 that will not. A check of the first thousand names in each of the directories of these two societies shows only 30 names that are common to both. Since about 70 per cent of the A. A. E. membersship is in the civil engineering field, it follows that, up to the present at any rate, the A. S. C. E. memberships shows only about 4 per cent overlap on the civil engineering membership of the A. A. E. If this percentage can not be greatly increased, and if the A. S. C. E. does not join the Federation, there will be many civil engineers who will not be supporting any organization that is specializing in what may be broadly termed "public relations."

Other than men in the civil engineering field, the percentage of the A. A. E. membership is small. While this ratio may increase, it is quite apt not to do so very greatly; and, if it should not, the result would be to leave the mechanical, electrical and mining engineering fields with inadequate representation in any "public relations" society other than the Federation.

It should not be forgotten that the majority of civil engineers are public or quasi-public servants, and that this is not true of any of the other three great classes of engineers. "Public relations" activities therefore naturally appeal much more strongly, on the average, to the civil than to mechanical, electrical or mining engineers. Hence the pronounced success of the A. A. E. in its campaigns for members in the civil engineering field, and the relatively small success in other engineering fields. It seems to us, therefore, that it would be very unfortunate were the A. A. E. to regard the Federation with jealous eyes, for the Federation will embrace a great number of engineers who are not likely ever to join the A. A. E.

We repeat what we said months ago, that there is work enough for both these organizations, and that the competition, such as it is, will be more helpful than harmful to either of them.

American Road Builders' Association Elects Officers.—At the annual meeting of the American Road Builders' Association on Nov. 15, the following officers were elected: President, M. J. Faherty, President Board of Local Improvements, Chicago, Ill.; Vice-President, Northeastern District, J. A. Duchastel, City Engineer, Outremont, Canada; Vice-President, Southern District, Lt.-Col. H. L. Bowlby, Chief, War Materials Division, Bureau of Public Roads, Washington, D. C.; Vice-President, Central District, Robert C. Terrell, State Engineer of Oklahoma, Oklahoma City, Okla.; Vice-President, Western District, S. Benson, Chairman, Oregon State Highway Commission, Portland, Ore.; Secretary, E. L. Powers, editor, "Good Roads," New York, N. Y.; Treasurer, Senator James H. MacDonald, New Haven, Conn. Directors for three years were elected as follows: Northeastern District, Irving W. Patterson, Chief Engineer, State Board of Public Roads, Providence, R. I.; William R. Smith, President, Lane Construction Corporation, Meriden, Conn.; John Swan, Director of Public Works, Pittsburgh, Pa.; Southern District, J. H. Cranford, President, The Cranford Paving Co., Washington, D. C., and W. G. Sucro, County Roads Engineer, Baltimore County, Towson, Md.; Central District, W. A. McLean, Deputy Minister of Highways, Province of Ontario, Toronto, Ont., Canada; Western District, Austin B. Fletcher, State Highway Engineer of California, Sacramento, Cal.

Tanks for Snow Removal.—Soon after the armistice it was suggested to the French Government that tanks might prove very useful on mountain roads. This suggestion was put into practice, and, according to The Canadian Engineer, has been attended with considerable success, tanks climbing rocky passes quite impossible for other vehicles. This idea has now been enlarged, and this winter it is proposed to use tanks as snow sweepers on several important routes which have hitherto been closed during the winter owing to the cost of keeping them open. Experiments show that when snow cutters are attached to the front and sides of a tank a path 10 ft. wide can be cleared with little difficulty and with relative speed.

The Economic Fallacy in "Back to the Farm" Propaganda

By HALBERT P. GILLETTE, Editor

The average business or professional man is accustomed to do not a little thinking about his own economic affairs, and in consequence comes to the belief that he understands at least the broad principles of all economics. But this conclusion is unfounded, for in the realm of social economics there are principles not ordinarily encountered in business.

Another thing that misleads the average man is his tacit belief that what is true of each of the parts is true of the whole. It is easy to show by examples that such a generalization is false, but the average man is so unsystematic in his thinking about matters outside his everyday affairs that he seldom pauses to examine the truth of generalizations that he uses only at long intervals. Consider, for example, the belief that a nation prospers in proportion as its exports exceed its imports. This fallacious inference is traceable to the false premise that what is true of the parts is true of the whole; for it is true that an individual becomes wealthy in proportion as his accumulation of money increases, which leads to the false conclusion that a nation becomes prosperous in proportion as gold is accumulated through foreign trade. Unless careful study is made of books on political economy, business men rarely perceive the falseness of the reasoning that leads them to look upon an excess of exports over imports as being desirable. They fail to realize that an increase of gold in a nation merely serves to increase prices levels, and leaves the average citizen no better off than before—often worse off, due to the unsettling effect of any great change in price levels.

For many years it has been a subject of complaint that the number of farmers in America is a steadily decreasing percentage of the total population. The recent census has led, on this subject, to a flood of editorial ink that would float a ship. Why is it a matter of so much editorial regret that our population is becoming progressively more urban and less rural? Is there some superiority in being a farmer? If so, the Russians might be expected to surpass all other nations, since 80 per cent of the Russians are farmers. And if there is any superiority in being a farmer, wherein does it consist?

In reply to such questions it is pointed out: (a) That a nation that does not produce enough food for its own use may become helpless in case of war; (b) that where farming predominates there is usually a greater belief in the sacredness of property rights, hence greater economic progress; (c) that country life is more healthful than city life; (d) that country life begets independence of character; (e) that it is conducive to thinking; etc.

The first argument (a) is met by replying that so long as a nation raises enough food for its own needs, there is no objection to a decrease in the relative number of farmers.

The second argument (b) is met by pointing out that workers can be induced to own their own homes, or to invest a considerable part of their incomes in stocks and bonds. There is nothing sacrosanct about owning farm land. Ownership of any property will suffice to strengthen the desire to increase one's income from investments and to become independent of charity in one's old age.

The third argument (c) is met by the fact that the death rate in the country is greater than in the average American city, and that, under proper conditions, as strong and healthy chindren are raised in suburban homes as in country homes.

The fourth argument (d) is mere assertion unsupported by data, and the same is true of the fifth argument (e).

In similar manner all the arguments in support of a relatively large rural population can either be refuted, or shown to be without sufficient economic weight to justify the conclusion based upon them. Even were it possible to show that certain economic gains result from a large rural population, it would have to be shown that those gains are not made at the expense of economic losses that more than offset them. In solving any complex economic problem there must be a balancing of the factors so as to secure a maximum of economy in the final result. This always involves economic losses in one direction that are more than offset by economic gains in another direction. Thus in designing a bridge consisting of a series of spans, any increase in the lengths of the spans increases their cost per foot at a rate that exceeds the increase in the span length. But on the other hand, increase in span length decreases the total cost of the piers by decreasing their number. The bridge designer therefore "balances" loss against gain, until he selects a bridge of least cost; and this he ordinarily secures when the total cost of piers and abutments equals the total cost of the trusses. If, however, bridge designers were to reason about their problems as most men reason about problems in political economy, we should witness debates about as follows:

> Engineer Smith: "I insist that [illegible] increase the number of piers [illegible] where they are [illegible] the loss of [illegible] at a [illegible] relatively small [illegible]. Suppose, for example, that [illegible] spans that I [illegible] were only the [illegible] that [illegible] purpose, and suppose [illegible] I per were to [illegible]. Those two spans [illegible] in your design two-thirds of your superstructure would be destroyed as contrasted with a [illegible] one-sixth of the superstructure if my design were used. Furthermore, when the [illegible] loads become much greater [illegible] will, consider the loss that will occur when your long and more expensive spans are removed. Contrast that with the possibility of replacing my steel truss spans with arches of reinforced concrete. Think of the saving, but especially think of the greater beauty of [illegible] concrete arches that will ultimately replace my truss spans!"
>
> Engineer Jones: "Let me call your attention to an oversight on your part, Mr. Smith. Your numerous piers are several fold more costly than mine. Moreover, they block the river and increase its velocity, thus increasing the scouring effect, which, you should remember, varies as the cube of the velocity, thus greatly endangering your piers. Consider, also, the unsightly appearance of your flock of piers in this noble stream. My design, by contrast, leaves the river almost unobstructed, preserving its pristine beauty, and even enhancing it by the almost majestic reach of those three graceful spans!"

By mingling economics with esthetic arguments, and by wholly ignoring the fact that a minimum annual cost for the entire bridge is the true aim of their work as economists, Smith and Jones might thus argue to eternity, without convincing one another, each partly right, each partly wrong, and neither of them reaching a correct solution of the problem in hand. Incongruous as such arguments appear to engineers when applied to engineering problems, arguments that are just as ridiculous are daily appearing in print relative to political economic problems. We have yet to accustom ourselves to applying the same scientific criterion to problems of political economics as to problems of engineering economics.

Let us close with a suggestion as to preliminary steps to be taken in solving the problem of what is the most economic proportion of farmers in a nation.

To begin with, we must ascertain approximately the average per capita consumption of food. Let us assume that this is 4 lb. per capita per diem. Then we must ascertain the average per cent of food wastage between the farm and the consumer's table. From this we can deduce the total weight of food that must be produced annually on the farm, on the average. But we must allow for poor crop years, and this will necessitate a planting of crops in excess of the average consumption, at least to the extent that food storage falls short of the requirements. Assuming, then, that an ascertained acreage is thus estimated to supply the total food requirements, it follows that the number of farmers can be calculated. Any number in excess of the estimated total thus deduced will be distributed in one or more of three ways: (1) To act as a factor of safety in the event of unforeseen conditions; (2) to supply foreign demand for food; and (3) to engage in non-productive activities—pleasure, etc.

The mere statement of the problems in this manner shows at once that if agricultural machinery increases the productivity of the average farmer, there must be either a decrease in the number of farmers per 100 of population, or an increase in the idleness of farmers unless there is an increase in food exports. For half a century America has led the world in the development and production of agricultural machinery, and for 20 years it has also led the world in the scientific study of agricultural problems. Of necessity, then, America could not continue to maintain as large a percentage of its workers as farmers, unless it could steadily increase its exports of food. The latter it did not do, because other countries were learning to apply both our farm machines and our agricultural methods; and since the human stomach has a limited capacity, the output of farm produce has steadily increased faster than the demand for it. Advertising and salesmanship can not increase the total consumption of food—the 3 lb. per capita per diem. It can only divert the demand from one class of food to another—from prunes to raisins, from oranges to apples, from potatoes to post-toasties

Of all the things that mankind uses, there is no large class for which the demand is so inflexible as food. How futile, then, is all the argument and exhortation that we have heard in "back to the farm" propaganda. As an economic campaign it has been a dire failure, because it did not offer a truly economic solution of a social problem. For exactly the same reason the campaign to increase American farm output after the close of the World War was destined to collapse. Why increase that for which the demand is limited by the capacity of the human stomach in America and by the contents of the purse in Europe? Certainly unless we planned to extend either credit or charity to Europe, it was a futile procedure to urge our farmers to greater productivity. Nevertheless our daily press has teemed with just such urging.

To me it seems clear that we should apply to problems of political economics the methods that engineers so successfully apply to problems of engineering economics. A few facts are not to be seized here and there, and an argument built upon them. Generalizations are not to be used as premises without a thorough canvassing of the data upon which they rest. What is economically good for each individual apart from his fellows is not to be assumed to be economically good for a nation. Ethical arguments should not be mingled with economic arguments, any more than esthetic arguments should be mingled with either or both. Let each class of argument (ethical, esthetic and economic) proceed according to its own principles to a final conclusion. Then, let one or the other, or a compromise (clearly seen to be a compromise) be acted upon. If this is done, perhaps it may ultimately be seen that ethics is, after all, identical in its results with social economics.

Relation of Zoning to Work of City Engineer

The latest municipal activity, the zoning of cities, a movement which is growing rapidly in favor throughout the country, has been advocated chiefly on account of its effect in stabilizing property values and to a somewhat less extent as a health measure. Another feature of this movement which is of particular interest to municipal engineers, was pointed out by Mr. Edward S. Rankin, engineer in charge of Bureau of Sewers of Newark, N. J., in a paper presented at the last annual convention of the American Society of Municipal Improvements. An abstract of the paper follows:

In a city in which a stringent zoning ordinance is in force, the element of chance in the engineer's work is largely eliminated and decided economies effected whether it be in the laying out of streets, or in their paving, sewering or water supply, for it is obvious that with the assurance that a given section of the city will be occupied by a certain definite class and size of buildings, the engineer can much more intelligently design the public works necessary to properly serve that section.

In the final report of the New York Commission on Building Districts and Restrictions, Mr. Nelson P. Lewis has this to say in regard to the opening of streets in undeveloped territory: "One of the serious problems confronting my office in passing upon street plans has been the need of providing what may be an excessive width of streets where land is cheap, for fear that the building of a new transportation line, putting the land in close touch with the business center will result in an intense development by apartment houses, so that we have been obliged to guard against conditions which formerly prevailed on the east side of Manhattan and to insist upon a minimum street width which is more than the real need of the territory if reasonably restricted. If such development were confined, for instance, to two or three-story houses or in some cases to detached houses, we would not have been obliged to impose upon the property owners the cost of acquiring and then improving streets of greater capacity than they would need if there were some sane, reasonable plan for preventing over intensive development."

In another part of the report the same author says: "This city has suffered tremendous losses by the inflexibility of its street system, which instead of controlling a subdivision has been controlled by the habit of creating lots 100 ft. deep lying between streets 200 ft. apart and great enterprises finding themselves hemmed in by rigid street systems have been obliged to find new sites on the New Jersey meadows."

With a zoning ordinance in effect a street system can be laid out with streets of such width and such distances apart as best to serve the use to which the land will be put, and with the assurance that such use will be permanent. Parks and playgrounds can also be located where they will permanently be of the greatest service to the greatest number.

Perhaps the most obvious effect which zoning will have on public improvements will be in its relation to the paving problem.

In an industrial district durability and strength to carry the heaviest traffic will be the first consideration, while smoothness with an absence of noise will govern the selection of a pavement for a residence district. Of course these features are given consideration without a zoning ordinance, but there is no assurance that the character of the district will not change and the pavement become unsuitable. The writer has in mind a street in his own city paved a few years ago with telford. The street was well built up at the time with moderate sized one and two-family detached houses, but adjoining a new railroad spur. Almost immediately following the paving of the street factories began to appear, attracted by the railroad, with the result that inside of a year the pavement was sadly in need of repair and soon had to be replaced with more durable material. Had the street been restricted by a zoning ordinance to its original character, the pavement would have served every purpose for a number of years or had it been definitely placed in an industrial district the mistake of laying a telford pavement would never have been made.

The effect of zoning on sewer design, with the substitution of known factors for estimates based on the judgment of the engineer, is very marked.

The three factors governing the cost of sewers, length, depth and size are all affected by the character of the district to be sewered. In a small house, in the residence district, all streets must have sewers and, following the modern custom, connections laid to the curb for each lot approximately 25 ft. in width. For apartment houses, residences restricted to large lots, business or light manufacturing districts, the connections may be placed farther apart, while for heavy industries, one or two to a block are sufficient, and in some blocks even main sewers may be unnecessary.

One and two-family houses and industrial buildings, usually have cellars not to exceed 4 to 5 ft. in depth below the curb, hence a shallow sewer will serve every purpose, while apartment houses and particularly commercial buildings, require much deeper sewers.

The necessary size of a sanitary sewer omitting the factor of grade being governed entirely by the number of people served, can be determined very accurately, knowing the permissible height of buildings, and the proportion of building to lot area and particularly when, as is the case with the Newark ordinance, the maximum number of families allowed per acre is specified.

In estimating the required size for combined and storm sewers by the so-called national method, the uncertain but important factor of impervious area becomes a known quantity. As is well known, this factor may vary from 100 per cent for entirely built up areas down to 30 per cent or even less in suburban districts.

Without definite restrictions it is necessary to estimate the possible maximum length, depth and size for all parts of a city alike, but with a zoning ordinance in effect each section can be treated separately and sewers built to properly sewer such section alone. Mr. Homer estimates that from 10 to 15 per cent of the cost of the St. Louis sewers could have been saved had a definite plan for the development of the areas been adopted when the system was designed.

With the exception of the factor of depth similar remarks would apply to the water distribution system.

It would appear therefore that the municipal engineer should be one of the foremost advocates of the zoning of our cities

Relation of the Proposed Uniform Vehicle Law to Municipal Traffic Regulations*

By H. G. SHIRLEY
Secretary, Federal Highway Council

In drawing up the proposed uniform vehicle law a thorough study was made as to just how far this law should go in regulating and controlling traffic in municipalities, it being realized that in the large centers of population a special control of traffic was necessary and should be provided. Therefore only the basic provisions that should govern and control traffic throughout the state were made state-wide. In arriving at these factors that should be made state-wide the committee carefully considered the effect they would have on the safe and expeditious handling of traffic in all municipalities and towns, and the good that would come from such a general regulation.

We have seen in the earlier days of motor legislation every district, town, municipality, and county specified a certain speed, load, kind of tire, lights, signals, etc., that should be used. Each unit of government having a different requirement thereby forming a hodgepodge conglomeration of laws and ordinances, making it impossible for any individual to operate a vehicle without violating many of their provisions. Under such conditions abuses crept in. Slow rates of speed would be established, and everyone who passes through the village exceeding this speed would be arrested, a heavy cost placed against the operator, and a small fine. The cost was divided between the officer making the arrest, and the magistrate and was a very profitable business, whereas the amount going to the town or village was exceedingly small. This abuse alone made it imperative to have a uniform speed throughout the state. Therefore to properly govern the transportation on the highways and bring it under reasonable control it was necessary to establish a few fundamental principles that should not be interfered with by city or town ordinance, and that these principles should be recognized by all municipalities, and coordinated with such additional regulations as may be necessary.

In drawing the proposed uniform law it was specified that no other license fee other than the one paid to the state should be levied against any vehicle with the exception of the property tax placed on all property. The minimum rate of speed was specified for open country, suburban sections, and closely built up sections of cities and towns, giving the municipality the right to increase the speed if it deemed advisable, but under no condition should it be diminished.

A study of the ordinances of the larger centers of population was made and it was found that on certain boulevards a higher rate of speed was allowed than proposed. It was therefore considered advisable to allow cities or towns to establish a rate of speed in excess of that considered safe on narrower streets under heavy traffic. The provisions proposed to be state-wide are as follows: License fee, signal devices, brakes, load plates, lights, speed, weight, length, width and height. (Length is not supposed to cover motor-driven street cars.)

The license fees are based on the horsepower plus a charge for 100 lb. per gross of vehicles and load; pneumatic tires on the basis of 50 per cent lower than that of steel.

Every motor vehicle shall be required to be equipped with a signalling device or suitable horn for producing an abrupt sound as a signal or warning of danger.

Suitable brakes shall be required—two sets operating independently. All vehicles shall be equipped with a load plate, giving the actual weight of vehicle, with equipment and the weight of the seating or loading capacity of such vehicle as specified by the manufacturer.

Lights on all vehicles shall be such as to give sufficient power to enable the operator to proceed with safety to himself and the other users of the highway. Every motor vehicle shall have mounted on the right and left side of the front a pair of lamps, and if said vehicle is so mechanically constructed, governed or controlled that it cannot exceed a speed of 15 miles per hour it shall have front lamps capable of furnishing light of sufficient candlepower to render any substantial object clearly discernible on a level highway at least 50 ft. directly ahead and to the front and at least 7 ft. to the right of the axis of such vehicle at a distance of at least 25 ft. If the vehicle can exceed a speed of 15 miles per hour, then it shall have front lamps capable of furnishing light of sufficient candlepower to render any substantial object clearly discernible on a level highway at least 200 ft. directly ahead and at the same time at least 7 ft. to the right of the axis of such vehicle for a distance of at least 100 ft.; provided that no front lamp capable of furnishing more than 4 candlepower light shall be used unless it shall be so designed, equipped or mounted that no portion of the beam of light when projected 75 ft. or more ahead of the lamps shall rise above a plane 12 in. above and parallel with the level surface on which the vehicle stands; and provided, further, that no electric bulb or other lighting device of a greater capacity than 32 candlepower shall be used, no matter how the same may be shaded, covered or obscured.

(A) VEHICLES DESIGNED FOR CARRYING NOT MORE THAN SEVEN PASSENGERS.

Maximum weight of vehicle and load.	Open country speed.	Suburban speed.	Close street speed.
[illegible]	[illegible]	[illegible]	[illegible]

(B) OTHER VEHICLES EQUIPPED WITH PNEUMATIC TIRES.

Maximum weight of vehicle and load.	Open country speed.	Suburban speed.	Close street speed.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
12,[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
28,[illegible]	[illegible]	[illegible]	[illegible]

(C) VEHICLES EQUIPPED WITH SOLID TIRES.

Maximum weight of vehicle and load.	Open country speed.	Suburban speed.	Close street speed.
[illegible]	25 [illegible]	20 [illegible]	15 miles
[illegible]	20 miles	18 miles	12 miles
[illegible]	18 miles	15 miles	12 miles
[illegible]	16 miles	15 miles	12 miles
[illegible]	15 miles	15 miles	12 miles
[illegible]	15 miles	15 miles	12 miles
28,[illegible]	15 miles	15 miles	12 miles

No vehicle of four wheels or less, whose gross weight, including load, is more than 28,000 lb.; having a greater weight than 22,400 lb. on one axle, and no vehicle having a load of over 800 lb. per inch width of tire upon any wheel concentrated upon the surface of the highway shall be operated on the highways of this state, except by special permit granted.

No vehicle shall be operated on the highways whose length is more than 30 ft. and no combination of vehicles coupled together shall be so operated whose total length, including load, shall be greater than 85 ft., except by special permit.

No vehicle shall be operated on the highways whose width, including load, is greater than 96 in., except traction engines whose width shall not exceed 108 in.

No vehicle shall be operated on the highways whose height is greater than 12 ft. 6 in.

The provisions of license fee, gross weight, weight per inch width of tire, the maximum speed, length of vehicle, width of vehicle and height of vehicle, kind of lights, signal devices, tires, and certain simple fundamental rules of the road are made state-wide, but the rules of the road do not interfere with the traffic plans of any city where traffic regulations are provided. It was, however, deemed prudent and advisable to make a few traffic provisions state-wide so that chauffeurs and operators of vehicles would know the general rules of the road and would operate their vehicles in accordance therewith.

A motor vehicle has flexibility and is capable of carrying loads over large areas. It is not confined to towns or municipalities, and it was necessary to make a few fundamental principles of this law state-wide, so that a driver of a motor vehicle would know exactly what to do and what was required of him in operating his car over the highways. The main object of drawing this law was not to restrict but to expedite the handling of traffic and for the protection of property and lives of the people. When a driver has become familiar with this law he will be able to operate his vehicle in any town or city without violating any of its provisions, and it will in time become so well known that in the movement of traffic every driver will fall into his proper place, which will expedite the movement of vehicles to a very great extent.

It must be clearly understood that this law is not to supersede or in any way curtail the handling of traffic by traffic officers in large cities. That is a problem of the greatest importance and means much to the economical welfare and progress of such a municipality, but it is very essential that all the people of a state should know the speed allowed throughout the state, character of lights, the signal devices, the requirements as to loads, tires, length width and height of vehicles so that a man traveling from one town to another would not violate the common laws that should be known by every driver. This law applies to horse-drawn just as it does to motor-driven vehicles, and its enforcement should be in the hands of the police of the state outside of the municipalities and cities, but within the corporated areas should be administered by the police of the city.

---

*From a paper presented Oct. 14 at the 26th annual convention of the American Society for Municipal Improvements.

In drawing the proposed uniform vehicle law the committee kept in mind the necessity of making it as simple as possible, due to having it adopted by the legislatures of the different states, and it was only drawn to meet an emergency for a uniform vehicle law throughout the entire country.

Just a word as to the amount of money that can be saved by proper regulations and handling of traffic on the highways, that are daily becoming more and more congested. On a highway having 3,000 vehicles per day, and we have many having many times this number, if traffic officers are placed at cross traffic points, say, four points within a mile, and at each one of these points one-quarter of a minute could be saved making one minute saved at all four points per mile per team. This multiplied by 3,000 teams would make per day 3,000 minutes or 50 hours saved per day. At $3 per hour would mean $150 per mile per day plus the saving in time of the occupants, and, say, each vehicle carried two persons other than the driver, and their time is worth a dollar an hour, would $100 be saved in time, making a total saving of $250 per day per mile due to proper regulation. And this multiplied by 300 days would give $75 per mile per year saved, less the cost of the traffic officers which would not exceed $15,000 per year, $60,000 per mile per year saved by proper regulations and traffic control. This multiplied by the many important highways we have will give an enormous saving. We are informed that in the city of Chicago alone traffic is only moving about 33⅓ per cent of the time and standing about 66⅔ per cent. If by expert handling a small percentage could be added to its moving many millions of dollars would be saved to the people of Chicago. I am just bringing this to your attention to try and impress onyour mind the great saving that is involved in the proper traffic handling rather than looking at it from the restricted viewpoint of regulation and control.

Expenditures in 1919 on Rural Roads and Bridges.—During the calendar year 1919, 46 States of the Union expended over $100,000,000 on their rural roads and bridges, the Bureau of Public Roads of the United States Department of Agriculture recently announced. This total is made up of the actual cash expenditures for such items as labor, materials, supervision, and administration, amounting to $389,455,931, and convict labor and statute labor, the value of which, not definitely known, is estimated at about $132,000,000. So far as possible, all expenditures on city streets within incorporated towns and cities and all items of sinking-fund payments or the redemption and interest payments on road and bridge bonds have been excluded. The road and bridge expenditures for 1919 show an increase of approximately 33⅓ per cent over those of 1918 and 70 per cent over those of 1911. More striking, however, is the increase in the proportion of the total funds supervised by the several State highway departments. In 1918 the expenditures by or under the supervision of the State highway departments amounted to $117,285,268, while the local road funds over which they exercised no control whatver, amounted to $168,812,925. In 1919, however, the State highway departments supervised the expenditure of $200,292,694 as against the total of $189,163,237.

California to Go Ahead with Its Highway Construction.—The adoption of the highway bond measure at the Nov. 2 election will make it possible for the California Highway Commission to resume the extensive road building program that had to be badly curtailed months ago because of lack of funds. By providing for a flexible interest rate to meet changing conditions in the bond market, the adoption of the amendment places the commission in a position to raise money as needed to meet the expense of work authorized under the $40,000,000 bond issue of July, 1919. The act itself provides the Finance Board shall consist of the Governor, Controller, Treasurer, chairman of the State Board of Control and the chairman of the Highway Commission. These members are to serve without compensation or expense their function chiefly being to pass upon the interest rate at which a specified block of bonds is to be offered for sale.

Surfacing Old Asphalt Block Pavement With Sheet Asphalt

By F. H. GILPIN,

Engineer, Eastern Division, Asphalt Sales Department,
The Texas Co.

Because of the settlement of the old asphalt block pavement on Broadway, New York City, between 155th and 169th Sts., a sheet asphalt wearing surface has been laid this year over the old street. The asphalt block was laid in 1907 by the Harlem Co. on a concrete base, which was in turn supported by the roof of the old subway with an interlayer of stone and earth between. The original price was $1.31 per square yard for the wearing surface and $4.40 per cubic yard for the concrete base. Up to Jan. 1, 1919, the reported repairs were equivalent to about 20 per cent of the entire area of asphalt block.

It was decided to surface the old asphalt block with a sheet asphalt wearing surface in order to bring the street to the proper grade and renew the old surface. This work was done by the forces of the Borough of Manhattan with Joseph Brady as foreman in charge.

The steps in construction may be summarized under the following headings:

(1) Burning off of asphalt block wearing surface to a depth of ½ in. at the maximum.

(2) Scarifying asphalt block with specially designed rakes after the surface had been burned.

(3) Cleaning the surface after it had been scarified.

(4) Laying of sheet asphalt wearing surface in usual manner.

Owing to the extreme hardness of the asphalt blocks they were burned to a depth of not over ½ in. at the maximum. A Lutz heater with a 5 by 10-ft. burning hood was used to burn off the asphalt block. This work required the following crew:

1 man to operate the heater.
2 men with specially designed tools to rake and scrape the burned surface.
2 shovelers.
1 broomer with a wheelbarrow to clean the surface.

An average of 200 to 250 gal. of kerosene per day were used by the heater which covered about 600 to 700 sq. yd per 8-hour day.

After the asphalt block had been burned to a depth of not over ½ in., the surface was scarified by the use of a special type of rake. This rake is made of a heavy piece of sheet iron which is square at one end and pointed at the other. The square end is serrated or notched across its entire surface of 12 in., having teeth about 1½ in. deep. These teeth held down by the weight of the tool itself dig up the burned section of the blocks.

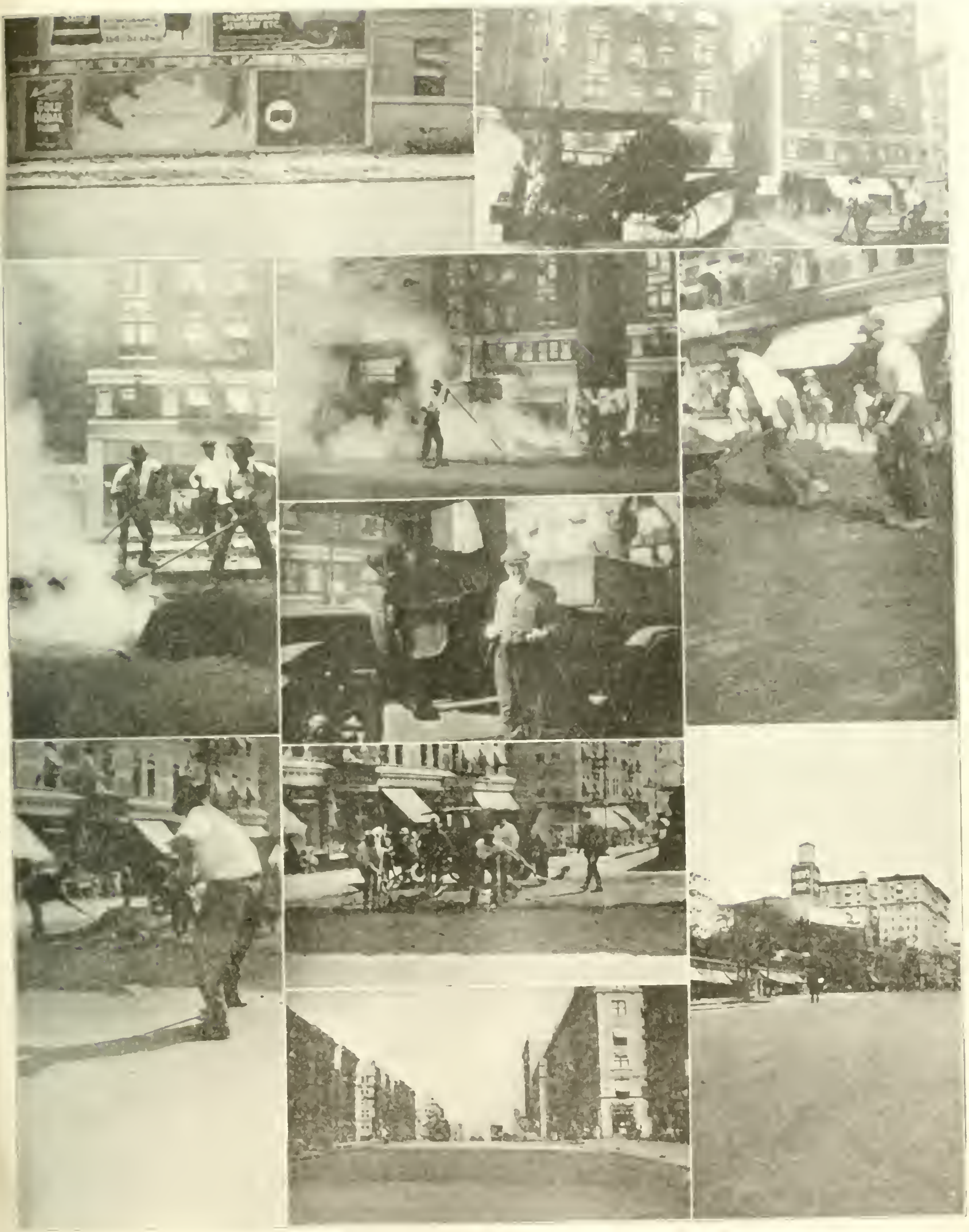
After the entire surface had been burned, then scarified with these special rakes, and cleaned, it was coated with hot asphalt applied in circular streaks by a whisk broom. This was done in order to insure a firm bond between the old asphalt block and sheet asphalt wearing surface.

The sheet asphalt top was spread in the usual manner to the proper grade, regardless of the thickness required. The mix was the same as is usually used in New York City for heavy traffic streets and was supplied by the municipal plant. The following gang was required to spread and roll the top:

4 shovelers (one of whom laid the paint coat).
3 rakers.
2 smoothers.
2 tampers.
1 8-ton roller and rollerman.
1 13-ton roller and rollerman.
1 rollerboy (who also tends fires and does odd jobs).

The illustrations on the following page showing the various stages of construction are illustrative of the manner in which the work was accomplished.

Highway Transportation Show.—A highway transportation show will be held at the 12th Regiment Armory, Columbus avenue and 62nd St., New York City, from Jan. 3 to 8th inclusive. It will be under the auspices of the Motor Truck Association of America, Incorporated, 144 West 65th St., New York City. The purposes of the show are: To further demonstrate both through discussion and display the necessity for a national highway system to support the general and economic use of the motor truck; to further educate the general public in the economic advantages, in the employment of the motor truck as a means of transport; to educate and sell prospective motor truck users.



Stages of Construction in Surfacing Old Asphalt Block Pavement at New York City With Sheet Asphalt.

Views from right to left show: West side of Broadway, showing displacement of asphalt block on down grade. Lutz heater with gang scraping and cleaning. Special rakers scarifying burning surface of block. Strip of unburned block between two burned sections. Clean surface showing streaks of paint coat. Motor trailer delivering top mixture. Spreading new wearing surface. Smoothing with hot iron. View of work showing old block in foreground. [illegible] block in middle foreground and new wearing surface in background. New wearing surface on east side of Broadway, north of 17[illegible] street.

Proportioning Concrete Aggregates When Unscreened or Pit Run Gravel Is Used

By L. A. DOAN,
Resident Engineer Indiana Highway Commission.

Specifications, particularly those for road and bridge work, usually prescribe concrete of arbitrarily selected proportions, such as 1:2:4, 1:2½:5 or 1:3:6, depending upon the nature of the work. Aggregates must be graded between certain limits, sand or fine aggregate usually being defined as that passing a ¼-in. screen, and coarse aggregate all that is retained thereon. In addition, a definite amount of cement per cubic yard is prescribed, based upon an assumed percentage of voids.

Unscreened or pit run gravel is usually permitted for certain classes of work, provided the ratio of fine aggregate to coarse, as defined above, is at least as great as that for the standard mix, and provided further that enough cement be used to procure the necessary ratio of cement to fine aggregate. It is often permissable, where the percentage of fine aggregate is excessive, to add screened gravel or stone, to make the resultant mix approximate the standard requirements.

Calculating the amount of cement required, or stone to be added as the case may be, often proves to be a tedious task, and various conclusions are apt to be obtained.

The accompanying curves have been devised to mechanically solve such problems.

It is necessary to first make an analysis of the material to be used. Determine the percentage passing and the percentage retained on a ¼ in. screen.

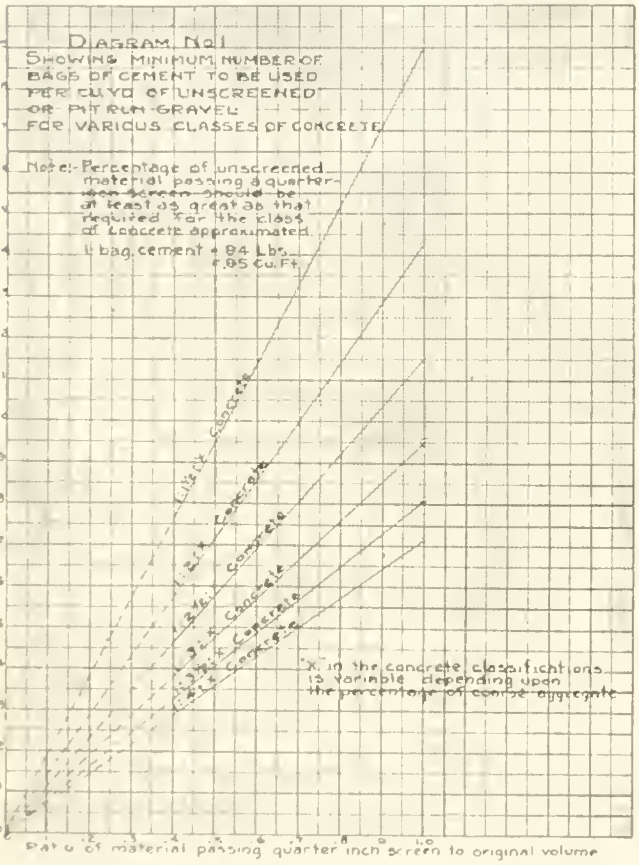


Fig. 1—Minimum Number of Bags of Cement to Be Used Per Cubic Yard of Unscreened or Pit Run Gravel for Various Classes of Concrete.

Where it is desired to use the pit run gravel without alteration, the number of bags of cement per cubic yard of concrete may be determined from the curves in Fig. 1. The diagram is self explanatory. Computations are based upon a cement bag of 0.95 cu. ft. The curves are applicable only in cases where the ratio of fine aggregate to coarse is at least as great as that required for the standard mix in question. Since the cement-sand ratio is the governing factor, the percentage of coarse aggregate does not enter into the computation.

Should it be desired to add screened gravel or stone, the amount of such which may be added to the unscreened material, per bag batch of concrete, may be determined from Fig. 2. It is first necessary to determine the amount of unscreened material to be used, from Fig. 1.

To demonstrate, assume that our analysis of the unscreened gravel shows 65 per cent (by weight) passing a ¼-in. screen, and 35 per cent retained thereon. A 1:3:6 mix is desired. From Fig. 1, we find that 6.15 bags of cement are required per cubic yard of unscreened gravel, or 0.16 cu. yd. of such gravel are required per bag-batch of concrete. The ratio of coarse aggregate to fine is 0.54. From Fig. No. 2, we find that 0.15 cu. yd. of screened gravel or stone may be added to secure an equivalent of a 1:3:6 mix. We now have one bag of cement to 0.16 cu. yd. unscreened material to 0.15 cu. yd. stone, and since the unscreened material is 65 per cent sand and 35 per cent stone, we have, reducing to bags as a unit, very nearly one bag cement, to 3 bags sand, to 6 bags stone.

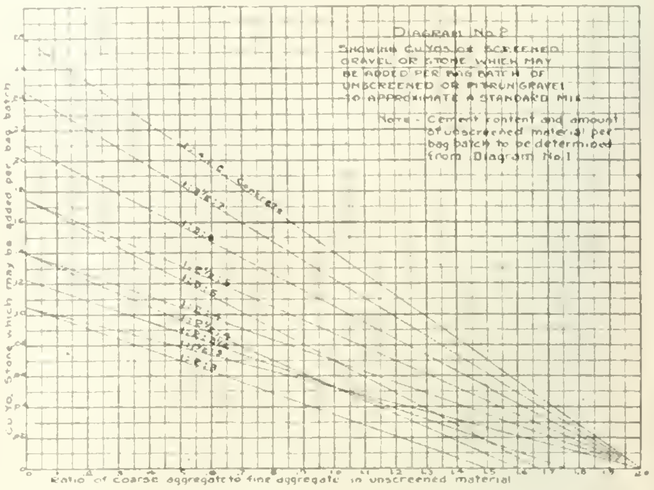


Fig. 2—Cubic Yards of Screened Gravel or Stone Which May Be Added Per Bag. Batch of Unscreened or Pit Run Gravel to Approximate a Standard Mix.

The equations of the curves are simply derived, and prove their authenticity.

Figure 1:

Let X = cu. yd. fine aggregate in 1 cu. yd. of unscreened gravel.
Y = required volume of cement, in bags.
A = required ratio of cement to fine aggregate.
C = .035 = constant to reduce bags to cu. yd.

$$A = \frac{CY}{X}$$

or

$$Y = \frac{AX}{C}$$

Figure 2:

Let A = bags fine aggregate required per bag batch for standard mix (i. e., required ratio of sand to cement).
B = bags coarse aggregate required per bag batch for standard mix (i. e., required ratio of stone to cement).
C = .035 = constant to reduce bags to cu. yd.
X = ratio of coarse aggregate to fine aggregate in unscreened material.
Y = cu. yd. of screened gravel or stone to be added per bag-batch.

Then bags of stone in the unscreened material, per bag-batch, will be AX.

$$\text{Then } AX + \frac{Y}{C} = B$$

$$\text{or } Y = C\,(B - AX)$$

Should it be desired to use an unscreened material in which the ratio of fine aggregate to coarse is less than that required for the standard mix, a similar pair of diagrams may be prepared by substituting fine aggregate for coarse and vice versa, in the above assumptions. In such cases, additional sand will be required when the ratio of cement to stone is made standard.

It is true that the amount of cement per cubic yard of concrete as poured, will be governed somewhat by such factors as the amount of moisture in the aggregate. The diagrams here discussed aim simply to give a concrete to comply with the specifications as written.

Recent Experiences with Wood Block Pavements*

By HERMAN VON SCHRENK
Of Von Schrenk & Kammerer, Consulting Timber Engineers,
St. Louis, Mo.

During the past two years numerous failures of one kind and another have been experienced with wood block pavements. Following periods of heavy rains during the summer of 1919 and at various times during 1920, wood blocks buckled and heaved and in some instances on long stretches of city streets the blocks floated away entirely. There also has been an increase in the number of cases of failure by decay of supposedly well treated blocks. Cases of excessive bleeding have also been reported, but less frequently than in former years.

In addition to the foregoing, a case has been reported of blocks shrinking excessively to such an extent that the blocks became loose in the streets. In view of these difficulties, particularly when taken in connection with the difficulty of obtaining both proper timber and creosote oil for its treatment, it is possibly not surprising that wood block paving has dropped somewhat in the estimation of some engineers.

These failures, so far as the writer has been able to examine them, have been due, not so much to any inherent defect of creosoted wood blocks as such, but almost wholly to conditions entirely within the control of the engineer. Many valuable lessons have been learned as a result of these failures and in the following it will be the endeavor of the writer to give a brief analysis of the underlying causes with some suggestions as to how these may be prevented.

Any consideration of wood block paving may be grouped under these five headings:

1. Kind of timber to be used.
2. Condition of timber.
3. Preservative to be used.
4. Treatment.
5. Laying.

In 1916 the Committee on Specifications of the American Society for Municipal Improvements adopted specifications for the timber, condition of the timber, the oil to be used in treatment and the treatment of wood block paving (see Proceedings 1916, pages 588 to 608). These specifications are in effect today with the exception of certain slight changes in the specification for preservative presented and adopted in 1918 (see Proceedings 1918, page 371). At the 1919 convention, the chairman of the Committee on Standard Specifications for Wood Block Pavements made the statement that these specifications appeared to be satisfactory and would insure a good, substantial, lasting block.

Timber and Preservatives.—Where the present specifications of the American Society for Municipal Improvements have been followed as to the kind and quality of timber, a reasonably dense, satisfactory block has been obtained and few, if any, failures have been reported because of the character of the wood used. In view of the failure of the sap wood of treated blocks, the writer has had numerous inquiries as to whether sap wood after all was not to be treated as a serious defect in a paving block. Sap wood as such, if sound, has all the strength qualities of heart wood. A study of the relative strength of sap and heart in Douglas fir shows that practically the weakest wood in the tree is in the center of the heart. The difficulty with sap wood is in the nature of the treatment rather than because it is sap wood.

Preservatives used during the last few years, while they have not always been in accordance with the specifications of the American Society of Municipal Improvements, have been more or less satisfactory and there has been very little complaint. The statement made by the writer before this organization in 1915 that the preservative is not the most vital part in a successful wood block paving holds today as well as it did then. Where a good coal tar product is used with a fairly high precentage of high boiling compounds, failures will be few and far between; in fact, the writer has yet to see any failures of blocks due to the oil used where such oil was a pure coal tar compound.

Treatment and Condition of Timber.—The treating specification as at present promulgated is very probably satisfactory in every way and there seems to be no reason to ascribe any of the recent failures to treatment.

The present specification provides that the timber may be either air-seasoned or steam treated, preferably be treated within three months from the time it is sawed. Recent experiences indicate that it may possibly be desirable to modify this clause to put a greater emphasis upon the necessity for having timber as thoroughly seasoned as possible; in other words, with a minimum moisture content.

Reference has been made to failures of sap wood. In 1915 the writer discussed in considerable detail failures which had taken place in various cities due to the decay of the sap wood of treated blocks and showed that this decay was due almost entirely to failure to obtain proper sap penetration. The sap decay of creosoted blocks has become more evident, not only on the streets then reported on, but on many new streets. Attention is again called to the fact that proper [illegible] can not be obtained unless the blocks are thoroughly penetrated with the preservative, meaning by this at least perfect penetration of every part of the sap wood. Penetration throughout the sap wood can only be obtained in all cases if the blocks are as dry as possible.

There is no question whatever but what many of the failures to obtain complete sap penetration are due to the fact that the blocks are not thoroughly dry and that water pockets were still present in the sap wood, thereby preventing complete penetration of the preservative. There is of course no use laying a block pavement if one cannot be reasonably certain that it will be protected against decay so as to give the maximum length of life.

No amount of steam treatment will make possible equitable distribution of creosote oil in a wet piece of wood. In this connection, it may possibly be of interest to explain that the initial steam treatment of paving blocks is for the purpose, not so much to get rid of water, as to assist in the driving out of the air, which is the principal factor causing bleeding after the blocks are laid in the street. Even if the use of thoroughly air-seasoned material did not appear warranted because of conditions to be described presently, it would nevertheless be necessary and desirable to treat air-dry timber for the sole purpose of getting better penetration than has frequently been obtained in the past.

Inspection and Laying of Blocks.—The present specifications of the American Society for Municipal Improvements call for careful inspection of the blocks after treatment by sawing a number of the blocks taken at random at right angles to the fibers through the center of the block. This is practically the only way in which one can detect the extent of the penetration of the preservative. In view of the sap failures, I strongly urge that at all times this method of inspection be rigidly followed at the time of treatment.

By far the largest number of failures of wood block paving in recent times has undoubtedly been due not to the blocks, but to the manner in which they were laid in the street. So much has been written about this subject in the past two years that it will hardly be necessary more than to indicate the present state of our knowledge of this exceedingly important factor.

In the early days of laying creosoted wood blocks when more or less rough concrete foundations were used, the sand cushion came into use largely to give a smooth base on which to lay the blocks. During the period of its more extensive use difficulties of all sorts arose. The blocks bulged in spots after rainfalls and after very heavy rainfalls whole street sections floated away. In many cases curbstones were thrown out of line.

Another difficulty occurred due to the shifting of the sand base, giving irregular depressions and frequently holes. It has long been realized that the employment of the sand cushion was largely responsible for the unwelcome swelling and the displacement of curbstone and surface. Water found its way between the individual blocks and was absorbed by the sand at the bottom of the blocks. The latter then swelled more at the bottom than they did at the top with the resultant disturbances.

It is this unequal swelling of the blocks that has probably been the greatest factor in the failures during the past two years. So common have these local eruptions become that they are considered by some to be a necessary evil in connection with the wood block. In spite of the fact that these experiences are now of many years' standing it is surprising to [illegible] how many cities still use the [illegible] particularly in view of the excellent results obtained in [illegible] cities with other methods.

---

*Paper presented at the recent annual convention of the American Society for Municipal Improvements.

Experiences at Chicago and St. Louis.—As a result of experiences with the sand cushion, a number of cities adopted the plan of laying blocks directly on the concrete base either with a thin cushion of sand-cement mortar or frequently on a perfectly smooth concrete with a bituminous coating. The first street of this sort laid was Dearborn St., Chicago, between Adams St. and Jackson Blvd., put down in 1914. The east half of the street was laid on a sand-cement cushion and the west side on a smooth concrete base with a bituminous coating. The writer is indebted to [illegible], Engineer of Streets, Chicago, for the following report on this street: "At the present time the west side of Dearborn street from Adams St. to Jackson Blvd., is in excellent condition with the exception of a couple of cup holes. Two yards of maintenance would make it perfect. This side of the street is where the heavy trucks unload mail and should show much more wear than the east side of the street. The east side shows much more wear and is very uneven and is full of depressions."

Another street with which the writer is familiar, laid shortly after (1915), is 15th St., St. Louis, between Olive and Washington. This was laid on a concrete base prepared with a smooth finish painted with pitch and the blocks laid directly on the pitch after it had cooled. It was then rolled with a light steam roller and the joints filled with pitch. This pavement is still in perfect condition. Very few pavements of this sort were laid, however, until comparatively recently. The abandonment of the sand cushion was followed most frequently with a sand-cement cushion laid dry and moistened immediately before the laying of the block. In many cases this has not come up to expectations. If the sand was at all moist at the time of laying, a very poor bond was formed and the mixture acted practically like a sand cushion.

Elimination of Heaving Effect Due to Water Absorption.—With the introduction of the smooth concrete base with a bituminous coating on which the blocks were laid directly, have come another series of problems of an entirely new character. In laying blocks on a sand cushion or on a sand-cement cushion, a filler of some sort was always specified to guard against admission of water between the blocks. Experience has shown, however, that even with the best care there was always sufficient space left to allow the water to percolate to the base of the blocks. Here it would stand for a short time and then be gradually absorbed by the base of the blocks, causing them to swell with consequent uneven expansion and heaving. With either the sand or sand-cement cushion there is, in other words, a material holding water in immediate contact with the highly absorptive lower surface of the blocks as distinguished from the bituminous surface which absolutely prevents water absorption.

In some cases (see Horner, Engineering News Record, April 22, 1920) the filler when softened under extreme street temperatures, flowed down under the blocks in an irregular manner and increased the chances during sprinkling or rainstorm for water admission to points immediately underneath the blocks. With the use of a bituminous coating on a smooth concrete base, particularly after the blocks were rolled, an almost water-tight condition obtained at the bottom of the blocks.

Explosions after rain-storms such as occurred on previous types of construction happened very rarely, if at all, on the bituminous concrete base. Blocks, in other words, were more or less protected from water on all sides except on top. The amount of water absorbed on the top by the blocks was very small and usually disappeared rapidly by evaporation after the rain or sprinkling. There was practically no tendency for the blocks to enlarge. On the other hand, it was found in a number of cases that blocks thus protected from water absorption lost the water during periods of high temperatures in summer and tended to become loose. This condition is very elaborately described by W. W. Horner, Chief Engineer of Paving, St. Louis, in Engineering News Record, April 22, 1920.

Three streets are described in this article. The blocks were laid on a smooth concrete surface, mopped with pitch at 140 to 145 melting point and the blocks laid after the pitch had cooled. Shortly after laying, the blocks contracted and became so loose that they had to be taken up out of the street, cleaned and relaid. On another street laid about the same time, where it was shady and the rate of evaporation of the water from the blocks was very much less, little difficulty was experienced as to shrinkage.

In the Oct. 7, 1920, issue of Engineering News Record, Mr. Horner describes the action of one of the streets last referred to, which had been laid in the summer of 1919 after the relaying of the street first mentioned where the shrinkage had been so high. The blocks in this second street were laid very tight, anticipating a possible shrinkage. In June of this year these blocks began to shrink just as they had on the street first mentioned. With an extremely ingenious device, fully described in the article cited, Mr. Horner took up the shrinkage, which amounted in one case to a total of 1.3 ft. in 125 ft. After the complete closure of the blocks on this street, with terrific rain-falls coming early in September, there was not the slightest movement on the pavement in any direction. An almost ideal condition has been obtained, namely, blocks were protected against water at the base by the pitch coating, on all sides by the pitch filler, and the tops of the blocks, while not quite as effectively waterproof, absorbed only small quantities of water which disappeared rapidly after the sun came out. In other words, the heaving effect due to the absorption of water at the base of the block was almost entirely obliterated.

The great trouble breeder with wood block paving, aside from the question of bleeding, has been water—water absorption and water loss. Water absorption causes expansion which, when it takes place unevenly as it has done in the cases of the use of sand cushions and frequently sand-cement cushions, brings about upheaval in the pavement and entire destruction of the street during heavy rain-storms. Water evaporation has caused loose blocks and a constantly disturbed street surface. The ideal condition is one in which the blocks are so prepared that they may have a minimum amount of water in the wood to start with and then to have them so protected that they will have little opportunity for absorbing water. The nearest approach to such a condition will undoubtedly be obtained as indicated by Mr. Horner, by treating as thoroughly air dried timber as can be obtained, then laying the blocks on a smooth concrete foundation with proper pitch surface, taking care to lay the blocks as tight as possible, and then providing a thoroughly acceptable pitch filler. This practice is now being followed in some of the newer streets which have been laid in St. Louis.

Summing up the foregoing, experiences of the past few years seem clearly to indicate that the proper precedure to obtain maximum service from wood block pavements is to follow the specifications for timber preservative and treatment prescribed by the American Society for Municipal Improvements, with possible modification to the treatment specification looking toward the treatment of thoroughly air-dry timber. This should be followed by blocks laid on a thoroughly smooth concrete base, with a good pitch coating, blocks laid as tight as possible, with a good pitch filler. When this procedure is followed, there seems to be no reason to anticipate any of the difficulties which have worried the street engineer during the past few years and should once again put this useful material to the forefront in all street construction.

Cost of Motor Truck Operation at Los Angeles.—The Engineering Department of Los Angeles, Calif., owns 33 trucks or touring car chasses equipped for truck service. The average daily cost of operation for each class of truck is given below, the figures being taken from the report of John A. Griffin, City Engineer, for the year ending June 30, last:

	Cost per day operated.
1 ¾-ton	$ 7.30
1 1-ton	7.32
2 1-ton	7.45
4 1-ton	7.01
1 ¾-ton	8.51
1 1½-ton	8.15
2 2-ton Republic	9.29
6 2½-ton (garbage)	11.30
1 4 ton	12.15
3 5-ton (oil spreading)	15.72
10 two passenger Fords (sprinkling)	6.52

The figures include the cost for maintenance, tires, fuel and expense and depreciation of and interest on the trucks and the salary, or wages, of the driver. Since prices of fuel and supplies rose during the year and wages advanced, the present cost of operation is about 8 per cent more than the above averages.

How Maryland Is Improving Its Improved Roads*

By J. N. MACKALL,
Chairman Maryland State Roads Commission

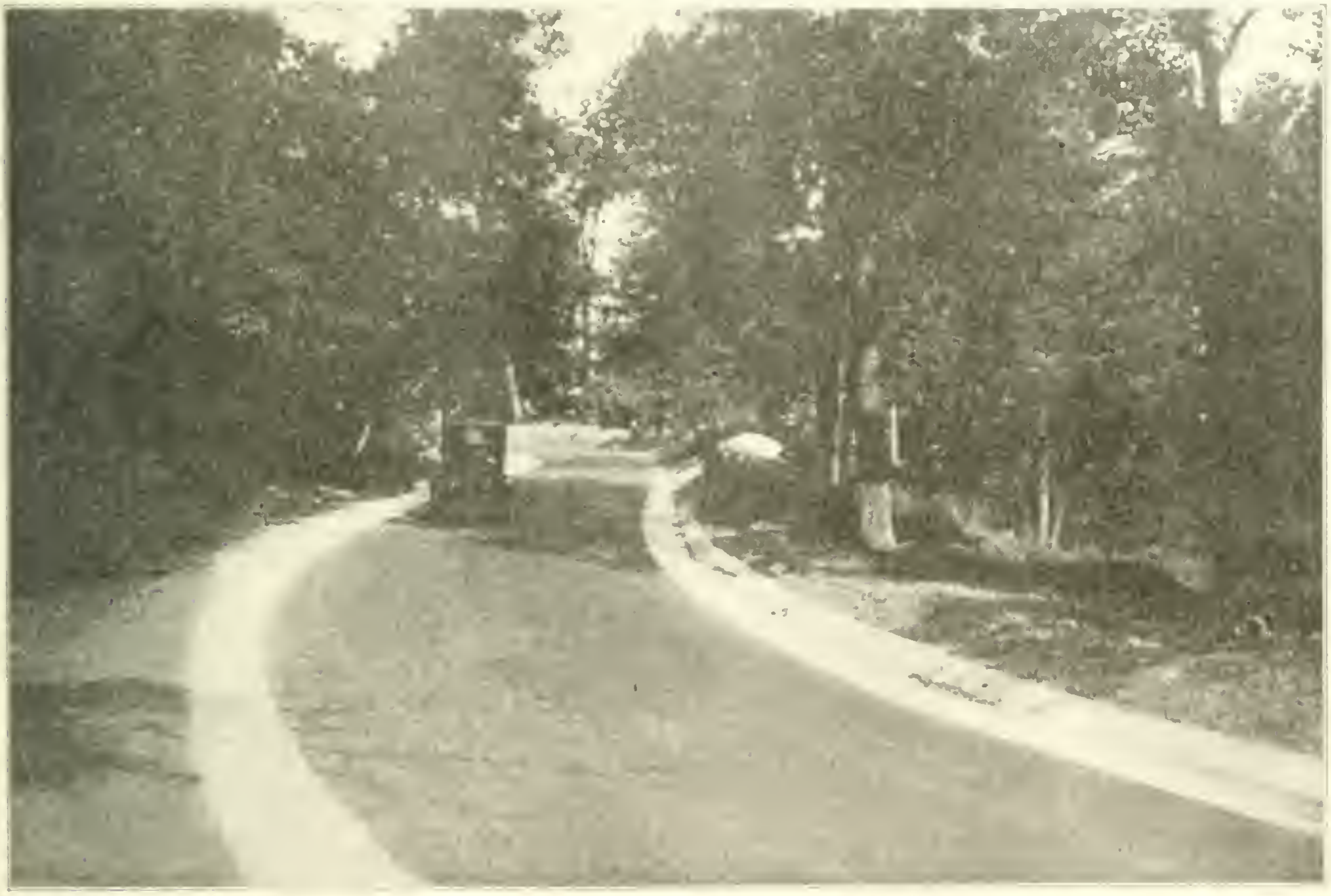
In 1908, Maryland embarked on a program of extensive highway improvement. Five million dollars was appropriated for the purpose, a sum which at that time appeared so large that many people throughout the state believed that the height of extravagance had been reached. The commission adopted a policy of building roads as good as the taxpayer was willing to pay for, roads which would meet reasonably well the traffic of the time and of the immediate future, leaving the unforeseen future to care for itself.

The average cost of the roads built from that first appropriation was less than $10,000 per mile. In some cases the work entailed considerable grading and drainage but in others it amounted simply to resurfacing the old turnpikes, which had already been graded and drained, which kept the average cost down to the low figure of $10,000. Generally speaking, the roads built at that time were of macadam 12 ft. in width, and 6 in. in thickness, but the width was soon increased to 14 ft.

To date there has been spent in excess of $30,000,000 for a system of improved roads. All county seats and all towns of 1,000 people or more are connected by good roads, which enable the farmer to haul his produce to market and the city man to send his product to the farmer. Her roads explain why Maryland has taken the lead among all the states in the development of rural motor truck express service. They have brought general prosperity to the state. Maryland people are firm in their belief that they have earned their cost, and if they require rebuilding today, the state is better able to rebuild them now than it would have been to have gone without them.

The point is that the perfect maintenance which all the roads of the system have received from the day they were completed, and the systematic scheme of gradual improvement which is now being worked out will enable many of the roads to give satisfactory service for years to come and they will give that service at much less expense than the cost of roads of higher type at the present time.

Widening Macadam Roads by Concrete Shoulders.—Striking examples of the improvements which are fitting these roads to carry the increased modern traffic are to be found on the main road between Philadelphia and Washington through Baltimore. The section between Belair and Washington, a distance of more than 50 miles, has been widened from 12 and 14 ft. to 20 ft. by the construction of concrete shoulders on each side of the existing macadam, and in the process of widening the crown of the road has also been made to conform to modern standards. The old roads had a crown of ¾ in. to the foot, which made the sides so steep that the traffic was forced to cling to the center of the road, because to get on the sides meant sliding to the shoulder and gutter. All traffic, therefore, concentrated in the center, except that as the volume of traffic increased it was necessary to pass other vehicles more frequently, which meant going over to the side, and "chewing" off the edge of the macadam. The concrete shoulders have been so constructed as to remedy this condition as well as to widen the road.



Old Macadam Road Widened by Concrete Shoulders. Trees and Boulders by Roadside at Curves Are Whitewashed.

The surface of the shoulders is about 2 in. lower than the center of the road, and from 2 to 5 in. higher than the old surface of the macadam adjacent to the shoulders. The road surface has been brought up to the height of the shoulders by the addition of a wedge of bituminous macadam material which has a depth of from 2 to 5 in. adjacent to the concrete, and tapers off to a featheredge at 2 to 6 ft. from the shoulder.

This unusual construction has given eminent satisfaction. No difficulty whatever has been experienced in keeping the macadam in place. The concrete on the side prevents the spreading disintegration of the macadam, and the macadam is thickened on the edges where it is normally weakest. Some of these sections have since been surface treated over the entire width, and it is impossible now to tell which part of the surface is the original macadam, and which is the section filled in. The method of treatment enabled traffic to use the road at all times during construction, and best of all resulted in a road surface which is satisfactorily carrying the heaviest of modern traffic without abandoning a dollar's worth of the original construction.

---

*From September issue of Public Roads, a publication of the U. S. Bureau of Public Roads.

New Roads Built Without Requiring Detours.—The principle of improving the roads of the system without interruption to traffic is one to which we try to adhere in all of our work, even when the old road is to be entirely reconstructed. When the new section of road is to be of concrete, we have adopted the plan of building the surface in two longitudinal sections with a joint running along the center. This form of construction was used on parts of the Washington-Baltimore road, several sections of which were completely destroyed during the spring of 1918. One half of the 20-ft. roadway was constructed at a time, allowing the traffic to use the other half of the road simultaneously with construction, first on the old roadbed, then on the new concrete. The two sections were tied together with ¼-in. round rods, 4 ft. long with one-half their length in each half of the pavement. They were spaced 2 ft. center to center along the road.

Some difficulty was experienced at first in keeping the traffic from running against the projecting rods before the second section was laid; but this was overcome by laying old railroad ties or sticks of wood along the edge of the concrete to protect them. There has been no difficulty in maintaining the joint in the center of the road, as the 20-ft. width permits traffic to travel on each side of the road instead of in the center. In fact the joint has been of considerable advantage in an entirely unexpected way, in that it has apparently tended to divide the two streams of traffic and keep each to its proper side of the road. So satisfactory have been the results in this respect on this section of road, that we have drawn a black line down the center of other concrete roads of this width to serve the same purpose.

Eliminating Dangerous Curves. In addition to widening and thickening the roads the commission is taking every opportunity to eliminate dangerous curves and grades, or to treat them in such a way as to remove the danger. One of the most dangerous curves in the state was the famous "Dead Man's Curve," south of Elkridge, between Baltimore and Laurel. Hundreds of automobiles have been wrecked at this point, and there is a record of more than 30 deaths. While the relocation here does not make the road straight, it reduces the curvature at each end of the reverse curve to 9°, and affords a sight ahead for more than 300 ft. at all points in both directions. No accidents, serious or otherwise, have come to our attention since the curve was flattened, and it is apparently eliminated as a source of danger. The cost was $17,000, a considerable sum to spend on less than a quarter of a mile of improved road, other than for ordinary maintenance.

Another place which was especially dangerous was the Winter's Run hill south of Belair. While not as many deaths occurred at this point, the wreckage of automobiles was greater than at Dead Man's Curve. The grade on this hill is 6 per cent, but the alignment is a series of reverse curves on the side of a hill. The total length of the dangerous section on both sides of the run involves approximately a mile. It was impossible on account of the grades to straighten the line on this road but the "inside" of all curves was excavated to approximately 4 ft. above the crown of the road for a sufficient distance to permit the driver of a machine to see at least to the next curve from 300 to 400 ft. ahead, and the material so excavated was deposited on the "outside" of the curves so that vehicles would not skid over the bank.

It was felt that to excavate these banks to the grade of the road would defeat the purpose in view, which was to hold the traffic out from the bank a sufficient distance to permit drivers to see around it, and if the curves had been excavated to the grade of the road, traffic would unquestionably have "hugged" the bank, and made the place as dangerous as ever. The material deposited on the outside of the curves was placed along the shoulder, and for a height of at least 4 ft. on a slope next to the road of about 1 to 1. The shoulders were surfaced over to the bank on the inside and on the outside the pavement was raised to extend up to the artificial embankment, thereby giving a super-elevation sufficient to compensate for the curvature. The cost of this work was approximately $10,000, and in this case, as at Dead Man's Curve, there has not been an accident of any kind which has come to the attention of the commission since the improvement was completed, now nearly two years ago. Numerous other curves have been treated in a similar manner, but to a very much less degree than at this point.

Macadam Roads Have Given Good Service.—Macadam roads, a number of which are only 6 in. in thickness, except on the very heavy traffic streets, have given splendid satisfaction, and are rendering a road service equal to that rendered by much more expensive highways in other sections of the country. but this service is only rendered by continuous, perfect maintenance at all seasons of the year. Perfect is probably a rather strong term, yet it is the only word which expresses the writer's idea. No hole of any size is permitted to remain in the surface of any road. A patrol system which works with the smoothness of a well-oiled machine is responsible for this condition. Holes can be repaired as soon as they appear, or before they appear, only by the patrolman, so the patrolman has been impressed with the fact that perfect maintenance on low-grade roads can only be brought about by the patrol system. If these roads are not patrolled and perfectly maintained, in an incredibly short time they become worn out, and soon impassable, as is demonstrated by numerous sections of roads built in the state by the counties, and maintained, or rather not maintained by them.

The macadam roads in particular must be surface-treated with the best material obtainable, a material which will render the surface at all times impervious to water, yet, one which will not cause the surface to roll, become wavy, and soon go to pieces. The accomplishment of this is not entirely a matter of the selection of the bituminous material and the application of it, but also the selection and application of the mineral aggregate covering.

Coarse Stone Used for Surface Treatment.—The commission has successfully used naptha cutback asphalt, water-gas tar, and coal-gas tar, so that it is not limited to any one bituminous material, but it does use a very large mineral aggregate covering in large quantities, and has it thoroughly rolled into the surface. The specifications now require material to be free from dust, and to pass through a revolving screen having circular openings 1¼ in. in diameter. Of course, a material of this size could not be used because of the damage to tires, unless it were immediately and satisfactorily rolled into the surface. The commission, therefore, insists that from one to two rollers be used with every distributor, and on the Frederick Road out of Baltimore, during 1920, five rollers worked 16 hours per day with two distributors. It is necessary that these chips be rolled into the surface and be kept rolled into place until the material has set up. Sand or small chips have a tendency to form a mat on the surface, which invariably pulls off, or waves, whereas the larger chips are pressed down into the surface and "key" together the new and previous applications.

On roads which have been treated for a number of years, an application of only from ¼ to 1/5 gal. of bitumen to the square yard is used, and from 100 tons to 120 tons of stone chips to the mile for a 15-ft. macadam road. There is great danger in too heavy or too frequent use of surface treatments. Applied too often or too heavily, the bituminous material forms a mat of considerable depth on the surface. In warm weather, and under heavy traffic, the mat begins to move and makes a very wavy surface, and it has been demonstrated conclusively that the use of heavy trucks on a wavy surface very soon causes the road to break through. A comparatively smooth surface is absolutely essential to the maintenace of any road subjected to truck traffic.

Roadside Stone Piles for Maintenance Purposes.—Another requirement, and a very important one for adequate maintenance of macadam roads, is to have along the road at convenient points, for use of the patrolman, material for patching any holes as soon as they develop. Especially is this necessary in the spring. In a climate such as Maryland's, the roads are frequently covered with snow for a month or two during the winter, and the use of trucks and motor cars with chains form ruts in the surface, which must be patched, as soon as the road thaws out in the spring. It is, therefore, absolutely necessary that material for this patching be delivered on the road in the fall. The need for early spring patching has eliminated from consideration as a patching material any emulsions which deteriorate from freezing. Regardless of how well these emulsions are adapted to summer and fall patching they are not used, because the possibility of not having material when it is neded in the spring more than offsets any advantage they possess at other seasons.

In conclusion, the writer believes that Maryland's policy which makes its necessary from time to time to improve her improved roads, is fundamentally sound and correct. Under it she has become one of the "best roaded" states of the Union. The improvements which keep her moderate-priced roads continually up to date cost far less than the high type roads which elsewhere are being built to carry traffic no heavier than her roads carry. The Maryland plan starts with a relatively small investment in admittedly low-type road. By a process of gradual improvement, by selective treatment of the weak places, it builds up a better road from year to year, always conserving the bulk of the previous investment. It is a plan which is more like the French plan than is to be found anywhere else in the United States. It differs sharply from the method which attempts by expenditure of vast sums to build at once, forever.

Experiences of Eastern Farmers With Motor Trucks

Information of much interest to highway engineers is contained in Bulletin No. 919 issued recently by the U. S. Department of Agriculture. The bulletin is based on the experience with motor trucks of 753 farmers in the states of Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland.

The farmers own trucks of all sizes and types from those of ½ ton to 5 tons capacity. The rated capacity of very few of the trucks is over 2 tons, however, and nearly half are 1-ton size.

Only 18 per cent of the farms are less than 5 miles from market, and nearly one-fourth are 20 miles or more. In the opinion of the owners of these trucks the principal advantage of a motor truck is in saving time and the principal disadvantage is "poor roads."

On the average it is reported that there are about eight weeks during the year when the roads are in such conditions on account of mud and snow, etc., that the trucks can not be used. Three-fourths of them usually travel on roads that are all or part dirt.

About one-fourth of the men have changed their markets, for at least a part of their produce, since purchasing trucks. For those who have changed their market, the average distance to the old market was 7 miles, and the average distance to the new market is 20 miles.

According to owners' estimates, each of the trucks travels an average of 3,829 miles per year and is used on 173 days per year.

Most of the owners of ½ and ¾-ton trucks prefer pneumatic tires, the owners of the 1-ton trucks are about evenly divided in their preference, but most of the owners of trucks larger than 1 ton perfer solid tires.

Over two-thirds of these trucks had not been out of commission when needed for a single day during the year covered by the reports, and nearly the same proportion of the owners stated that they had not lost any appreciable time on account of motor and tire trouble, breakage, etc. However, about 1 truck in 30 had been out of commission 10 days or more.

Return loads are available according to the reports for only about one-fourth of the trips.

The average cost of operating the trucks of various sizes, including driver's wages, as well as the strictly operating charges, was 50.1 ct. per ton-mile for the ½-ton trucks, 33.8 ct. per ton-mile for the ¾-ton trucks, 25.8 ct. for the 1-ton trucks, 24.2 ct. for the 1¼ and 1½-ton class, and the 2-ton trucks cost 18.2 ct. per ton-mile.

In the above data the drivers' wages included were 50 ct. per hour, gasoline and oil cost from about 2 ct. per mile for the ½-ton truck to nearly 4 ct. per mile for the 2-ton truck; tires cost 1.6 ct. per mile for ½-ton and 2.5 ct. for 2-ton trucks.

Only 1 per cent of the whole number of replies gave the saving of expense as the principal advantage derived from the use of trucks instead of horses. Two per cent regarded the superior convenience of the truck as its principal advantage; 2 per cent thought that the ability to reach better markets was their crowning advantage; 3 per cent looked upon the saving of horses as the best reason for the use of the trucks; but nearly all, 91 per cent in fact, gave as the principal advantage "the saving of time."

Specifications for Broken Stone Foundations for Pavements

At the recent convention of the American Society for Municipal Improvements the special committee on foundations for pavements submitted as a progress report the following specification which was prepared by Linn White, Chief Engineer, South Park Commission, Chicago.

Subgrade. In the case of the construction of new broken-stone foundations for pavements the subgrade shall be prepared by cutting or filling as may be required to produce a surface parallel with the finished grade of the wearing surface and a distance below the finished grade equal to the specified thickness of the foundation and paving material.

The subgrade shall be brought to a firm, unyielding surface by rolling the entire area with a 3-wheel road roller weighing at least 10 tons, and all portions of the surface of the subgrade which are inaccessible to the roller shall be thoroughly tamped with a hard tamper weighing not less than 40 lb., the face of which shall not exceed 80 sq. in. in area. All soft, spongy, or yielding spots and all perishable matter shall be entirely removed and the space filled with suitable material.

When considered necessary or of assistance in producing a compact, solid surface the subgrade before being rolled shall be sprinkled with water.

Sub-Drainage. When the soil is of such a character that it retains an excessive amount of moisture, such as clay subject to swelling or heaving under the action of frost, or sands similar to quicksand that do not afford a ready natural drainage, sub-drains should be provided.

These may be of two general kinds, first, tile drains of open porous material or vitrified tile laid with open joints; second, trenches filled with broken stone, gravel, cinders or other similar material.

In some cases it may be sufficient to construct a sub-drain on each side of the roadway at or near the lines of the gutters, but when the soil is of a very wet nature, it may be advisable to lay additional lines of drains which may be in or near the middle of the roadway. This system of drains may be varied by diagonal lines of drains running from near the crown of the roadway to the gutters.

In all cases the drains should have connections with the existing sewers, catch basins or inlets.

New Macadam Foundation. If the pavement is to be laid on a new macadam foundation, the macadam shall be built as follows:

The total thickness of the macadam base will vary according to character of soil, drainage, kind of stone available, etc. In general the macadam base should be constructed of broken stone which is sound, hard and durable under traffic. The broken stone should be separated into different sizes by screening, the smaller sizes with the dust being used to fill and bond together the larger sizes. The thickness of the base should be regulated by experience in constructing ordinary water-bound macadam roads in similar situations, the total thickness of base being made the same or a little less than well constructed macadam.

After the subgrade has been properly prepared, spread a layer of clean stone passing a 3 to 3½-in. revolving screen and held on a 2-in. screen to a depth sufficient when thoroughly rolled to form about two-thirds of the total thickness of the base. The thickness of this layer should be regulated by laying on the subgrade at proper intervals cubical blocks of wood of the proper dimensions to give the desired thickness or regulated by other means approved by the engineer. Over this layer of stone, spread with shovels stone screenings in sufficient quantity to fill the voids between the larger stone. The screenings should be spread gradually, and be thoroughly rolled with a road roller weighing at least 10 tons during the process of spreading the screenings. As the screenings are worked into the coarse stone under the roller, more should be added here and there where voids appear. At first the rolling should be done dry (working from the edges toward the center of the roadway), until the stone appears to be well filled, then the surface should be well sprinkled and again rolled, the rolling and sprinkling continuing until the layer of stone is thoroughly compacted and no more screenings can be worked in. Just enough screenings shall be used to fill and bond the stone, leaving no surplus screenings on the top.

The above method may be varied by using the crusher-run of stone without the addition of any other filler where the small sizes are not in excess. Also a filler other than stone screenings, such as bank gravel or sand may be used in some cases where experience with the material available shows that better results can be obtained. Under some conditions the character of soil and stone available may be such as not to require the use of any filler with the stone of the first course. The specifications given, however, represent the best average practice where stone with bonding value, such as limestone or trap rock, can be obtained.

When the first layer of macadam is completed as specified, spread a second layer of clean stone passing a 2 or 2½-in. screen and held on a 1-in. screen to a depth sufficient when thoroughly rolled to form the remaining one-third of the total thickness of the base. Over this layer of stone spread evenly with shovels stone screenings and roll with the application of water by sprinkling until the layer of stone is well filled, well bonded and firmly set in place. In the case of bituminous pavements just enough filler should be used to accomplish this purpose and not enough to form a layer or film over the surface of the stone. In fact it is better not to fill the stone quite flush, leaving the coarse particles of stone slightly projecting, so as to have a coarse, grainy base upon which to put the wearing surface. In the case of block or brick pavements, enough screenings should be used to produce a smooth, evenly filled surface.

The thickness of the base should vary according to local conditions and should be fixed by the engineer in charge when all the varying conditions of soil, drainage, traffic and materials of construction are understood. In general, a thickness of macadam base of 8 in. will be enough for any except the most adverse conditions, and a base of 4 to 4½ in. will meet the most favorable conditions of firm, unyielding soils and light traffic.

Old Macadam Foundation.—If the pavement is to be laid on an old macadam base, the surface shall be thoroughly swept and cleaned of all fine material that may be caked upon the surface of the stone or lying loose as dust, thereby exposing the clean coarse stone for the reception of the bituminous concrete.

If the old macadam does not present the desired coarse, grainy surface, or is not at proper and satisfactory grade after cleaning, it shall be spiked up and redressed to the desired crown and grade, the coarse stone being brought to the top by harrowing or otherwise, or new stone added when, in the opinion of the engineer in charge, it is needed to give the necessary thickness or character of surface. It shall then be thoroughly rolled with the use of water as may be required.

In the case of bituminous pavements a layer about one stone deep of new, clean stone, averaging 1½ in. in size, shall be spread over the surface after redressing and rolling the old macadam, and finally rolled until firmly set in place without the application of water. This is intended to form a coarse, grainy surface of fresh clean stone which will bond with the bituminous paving material.

Road Construction in Illinois. During the period Jan. 1 to Oct. 29, 1920, a total of 310 miles of highway were constructed under the supervision of the Illinois Division of Highways, distributed as follows:

	Miles.
Lincoln Highway	51
Dixie Highway	44
National Old Trail	64
Chicago-St. Louis Road	107
Chicago-Waukegan Road	6
State Aid Work	28

There are still uncompleted contracts on the above roads approximately as follows:

	Miles
Lincoln Highway	12
Dixie Highway	22
National Old Trail	53
Chicago-St. Louis Road	77
Chicago-Waukegan Road	14
	178

Motor Vehicles in the United States. According to available records there were in this country on July 1 7,901,271 motor vehicles. Of the total 631,983 were motor trucks. The Power Wagon estimates that a total of 785,000 motor trucks is much nearer the truth.

Capillary Movement of Soil Moisture

While written primarily from the standpoint of the irrigation, Bulletin No. 835 issued recently by the U. S. Department of Agriculture, describes tests and records observations that are of great interest to highway engineers.

Capillary attraction has for some time been recognized as a probable cause of the high moisture content of soils composing road subgrades under certain conditions, but unfortunately scientific knowledge of the movement of capillary water is exceedingly meager—so meager, in fact, as to provide no adequate basis for the development of measures of combating the conditions to which it gives rise.

The tests described in the bulletin include observations of the movement of moisture under the two commonly existing conditions:

1. Where the source of the moisture is a body of free water.

2. Where the source of moisture is a body of moist soil, not connected with a body of free water.

The soils tested were packed in flumes; some open so as to allow evaporation to take place, others closed to prevent evaporation. One side of the flumes was of glass so as to permit the movement of the moisture to be observed.

The flumes were set horizontally, vertically, and at various angles with the horizontal, and in each position were packed with a number of representative soils varying from light sandy varieties to heavy clay. This arrangement provided for the study of the rate and extent of the capillary movement in columns of various types of soil under conditions designed respectively to eliminate the attraction of gravity as a factor, to include it as a counter attraction to the capillary force, and to include it as an assisting force.

In connection with the experiments, records were kept of the air temperature and the evaporation from a free-water surface.

The results of the tests of vertical soil columns confirm in the main the observations of other investigators of the vertical movement of capillary water. The observations indicate that the rate of movement in the lighter soils is more rapid for the first few hours and then slows down much quicker than in the heavy soils. In general, it was found that the lighter the soil the shorter would be the distance the moisture would move upward in a long period of time.

The horizontal capillary movement of moisture has not been studied to any great extent before. In respect to the rate of movement in the lighter and heavier soils the phenomena noted in the case of upward movement are exactly reversed when the movement is horizontal. The extent of the movement in the various soils, with one exception, was in inverse order to their moisture equivalents. The light soil with the lowest moisture equivalent showed the greatest movement of moisture while the heavy soil with the greatest moisture equivalent showed the least movement of moisture. The lighter soils used the greater total quantity of water in long periods of time and moved it farther in the horizontal direction than the heavier soils. These are the opposite of the conditions noted in connection with the vertical movement, and should be of particular interest to highway engineers, in view of the fact that the horizontal movement of water from road shoulders toward the center of the pavement must be fully as great as the upward movement of water from underground sources.

The phenomena noted in connection with the movement in flumes tilted at various angles to the horizontal combine the characteristics of the movement in the two cardinal directions as might be expected.

Among the observations of greatest significance to highway engineers are those which refer to the effect of temperature upon the movement of capillary water. The experiments indicate that a temperature of from 26° to 32° F. has a marked influence upon soil moisture other than the mere fact of freezing. A number of the horizontal flumes tested when the temperature was or recently had been below 30°, consistently showed greater percentages of moisture near the top of the flumes than near the bottom. Basicly the percentage of moisture in the top samples should be less than that in samples from the bottom layers. In the first place gravity tends to draw the moisture to the lower layers. Secondly, evaporation tends further to reduce the moisture at and near the surface. Thus the laws of physics would indicate a lower percentage of moisture toward the top of the flume than near the bottom. There were, however, several instances where this relationship was interchanged, and more especially was this noticeable during the winter of 1916-17. When this interchanged relationship was observed so frequently during the spring of 1917 as to almost preclude the probability of error in sampling, it seemed evident that the unlooked for distribution of moisture was the result of some unusual condition. It soon became apparent that the top part of the flumes showed the greater percentage of moisture during only that part of the year when the air temperature was or recently had been below 20°. Looking back over the results of the preceding winter, the same condition was found. When these facts became evident it was so late in the season that there was no opportunity to prove the matter beyond a question of doubt. Before a definite conclusion can be drawn, therefore, additional experiments will have to be made. The covered flumes seemed to require a somewhat lower temperature to produce the condition than the open flumes. These observations are so suggestive as a possible explanation of the saturated condition of road subgrades in the spring of the year as to merit the fullest investigation by highway engineers.

Walter W. McLaughlin, senior irrigation engineer of the U. S. Bureau of Public Roads, is the author of Bulletin No. 835. The bulletin is now available for free distribution and a copy may be obtained by applying to the Chief of the Bureau of Public Roads, Washington, D. C.

Snowshoes for Horses.—Snowshoes for horses, according to a press dispatch, have been successfully used in hauling heavy freight from the Grand Trunk Pacific Ry. in Canada to the Spider claims on Salmon River. The snowshoes are of iron, a little wider than the horses' hoofs, but considerably longer. The frames are narrow iron rods, with thin strips of iron interlaid.

Missouri Votes $60,000,000 Bond Issue for Roads.—At the election Nov. 2 the proposition to issue $60,000,000 of bonds for roads carried by a majority of 233,000.

Super-Elevation and Widening of Curves on Minnesota State Highways

By J. T. [illegible]

[illegible] Construction Engineer, Minnesota Highway Department.

The State Highway Department of Minnesota has adopted a method of super-elevation and widening of curves on pavements that is designed to facilitate [illegible] field and office computations.

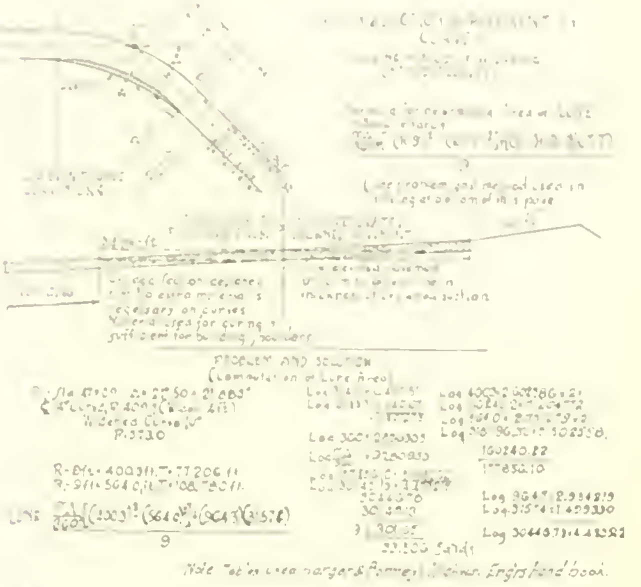

PROFILE AND SECTION
Note: Tables used are from Searles & Ives Engineers' Field Book.

Fig. 2—Plan and Section of Pavement at Curves, Showing Ring Method of Widening.

During the paving season of 1919 and 1920, the "Lune Method" of widening was used by this department. This method provided for an additional widening of 2 ft. on 5° curves and graduated uniformly to 7 ft. on 29° curves. It was found unsatisfactory for the following reasons:

1. The computations for area, as shown on Fig. 1, were long, tedious, and subject to variation in results where logarithms and calculating machines were used.

2. It required the use of a transit, for running in.

3. It increased the amount of field work.

4. The loss of any stakes during the setting of forms, required a transit party in the field, or the method of "fugging" to replace the missing stakes.

5. The desired additional width was obtained only at the center of the curve.

To offset these objections, it was decided to use a "Ring Method" of widening connected by two transition curves to the tangents. Curves up to 7° are super-elevated to compensate for a speed of 27 miles per hour. From 7° to 29°, the maximum super-elevation is used. There has been considerable argument about the amount of super-elevation to use, where to begin super-elevating and where to reach the maximum. After a study of the conditions by the engineers of this department it was generally agreed that for curves of 2° to 7°, the pavement should be super-elevated to compensate for a speed of 27 miles per hour, the

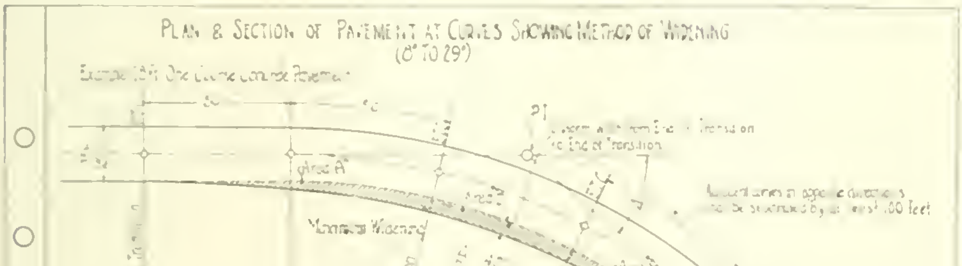

PLAN & SECTION OF PAVEMENT AT CURVES SHOWING METHOD OF WIDENING
(0° TO 29°)
P.C.
End of Transition
SECTION AT E.T.C.
SECTION AT P.C.C.+25
SECTION AT P.T.C.
The area of the extra pavement required is therefore 48.75 + 25.919 = 74.74 sq. yds.
From the same chart, the offsets to the transition curve from the inner edge of pavement are given for every 10 feet.

Fig. 1—Plan and Section of Pavement at Curves, Showing Lune Method Widening.

maximum super-elevation being ¾ in. per foot of width. It was further found that for curves ranging from 7° to 29°, the tendency of the average driver was to decrease his speed in an inverse ratio to the increase of the degree of curvature. The maximum super-elevation adopted for curves of 7° to 29°, compensates for speeds of 27 miles per hour for a 7° curve, decreasing uniformly to 12 miles per hour for a 29° curve. With the exception of right angle turns, the degree of curvature of the majority of the curves fall between 1° and 10°. After the maximum super-elevation is reached at 7°, the pavement is given a graduated additional widening, commencing with 2 ft. for 8° curves, and increasing uniformly to 5 ft. for a 29° curve. A uniform length of transition was adopted, and offsets and areas were computed and compiled as shown in the chart below (Fig. 3).

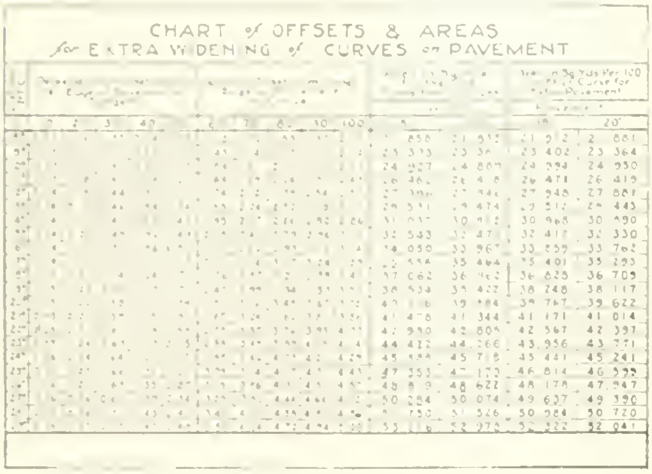


CHART of OFFSETS & AREAS
for EXTRA WIDENING of CURVES on PAVEMENT

Fig. 3—Chart of Offsets and Areas for Extra Widening of Curves on Pavement.

To further facilitate the field work, a super-elevation chart was compiled, giving the pitch per foot of width. For curves of 7° to 29° the super-elevation slab is of the same length as the transition curve. This enables the field man to set the additional widening and super elevation stakes in one operation.

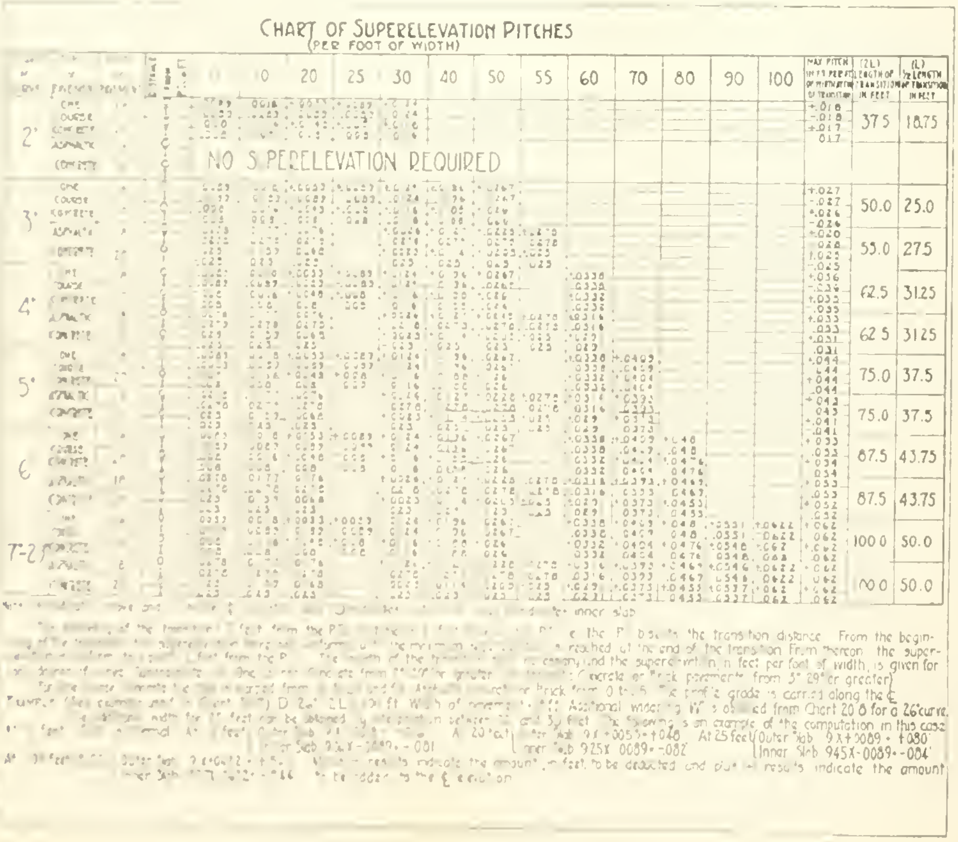


CHART OF SUPERELEVATION PITCHES
(PER FOOT OF WIDTH)
NO SUPERELEVATION REQUIRED

Fig. 4—Chart of Super-elevation Pitches.

Effects of Cal as Accelerator of Hardening of Portland Cement Mixture

The effect of calcium chloride in portland cement mixtures has been quite thoroughly investigated, and the use of hydrated lime in such mixtures is not uncommon in practice. There are no restrictions on the use of these materials in concrete, but their application in the form of calcium oxychloride, or "Cal," has been covered by patents. In view of the importance to users of cement and concrete of knowing the properties of the material and its value as an accelerator, a co-operative investigation was undertaken by the U. S. Bureau of Standards and the patentee. The results are set forth in Technologic Paper No. 174, written by Roy N. Young, associate chemical engineer Bureau of Standards, and issued recently by the Bureau. The following summary of the results of the investigation is reprinted from the above mentioned paper:

Cal is a material obtained by pulverizing the dried or undried product resulting from a mixture of either quicklime or hydrated lime, calcium chloride, and water. It is a dry white powder which may be handled in much the same way as hydrated lime, and with the same general keeping qualities. It is much more convenient to handle and use in making concrete than calcium chloride, either fused or in concentrated solution. Upon exposure to the air Cal gradually takes up carbon dioxide and becomes somewhat damp. However, tests indicate that long exposure does not affect its action as an accelerator of the hardening of portland cement mixtures.

The setting of normal portland cement mixtures may be hastened by Cal to an extent which is very desirable in concrete construction requiring a finished surface. The finishing operation may proceed with much less delay after the concrete has been placed, which should result in cutting down overtime labor. This hastening of the set is not objectionable in any type of construction providing the concrete is placed soon after it is gaged with water. It is believed that Cal increases the workability of portland cement mixtures. However, no attempt was made to measure the extent of this effect, because up to this time no satisfactory test has been developed for measuring the workability of portland cement mixtures.

Unsound cements may be greatly benefited or made sound by an addition of Cal. This effect was produced in neat pats subjected to the steam test and in mortar test pieces stored in air.

Limited tests indicate that quicksetting cements, either fresh or having become quicksetting on aging, may be made normal by the addition of Cal as used in cement mixtures.

There was no indication that the amount of efflorescence appearing on the surface of cement mixtures exposed to the weather is increased by the use of Cal.

The series of tests on the effect of Cal on steel reinforcing bars which were embedded in a thin layer of Cal cement mortar and exposed to the weather for eight months without showing any sign of corrosion, while favorable, is too limited to give assurance that corrosion will not occur under these conditions. Caution should, therefore, be exercised in the use of Cal in concrete containing steel reinforcement when the concrete is to be freely exposed to the weather or excessive dampness. It is believed that no bad effect will be produced in ordinary building construction.

Undried Cal mixed with portland cement caused greater deterioration in the quality of the cement during storage than that which ordinarily takes place. Therefore Cal should be added to the concrete materials during the mixing operation, preferably before the water is added.

All portland cement mixtures treated with Cal attained greater strength at the 2-day and 7-day periods than the corresponding untreated mixtures. The percentage increase in the strength of mortar at the 2-day period obtained by an addition of 5 per cent Cal to cement ranged from 40 to 110. The strength of the treated mortar at 2 days was equal to the strength of the untreated mortar at 4 to 8 days. These calculations are made from the results of tests in which the test pieces were stored in damp sand, or damp closet.

Treated mortars stored in the laboratory air attained at 2 days strength greater than that of the untreated mortars at 28 days. This was due to the rapid drying out of the small test pieces and the comparatively low rate of gain in strength after the 2-day period. However, this indicates that Cal is especially advantageous in cement mixtures which are necessarily subjected to any drying-out action.

The increase in strength produced by 5 per cent Cal in concrete mixtures at the 2-day period ranged from 52 to 135 per cent, and the strength of the treated concrete at the 2-day period was equal to that of the untreated at from 3 to 4½ days. On an average this represents a saving of approximately one-half the time in operations which are dependent upon the strength of the concrete at early periods. The effect of the air storage in the concrete tests was lessened in degree, owing to the high relative humidity which existed throughout the storage period.

It should be remembered that the increase in strength resulting from an addition of 5 per cent Cal does not represent the maximum which may be obtained except in very rich mixes. As much as 15 per cent Cal was used in mortar tests, giving an increase of 220 per cent at the 2-day period.

The general effect of Cal on portland cement mixtures is the same as might be expected from the use of equivalent amounts of hydrated lime and calcium chloride.

The 3-year tests by the Bureau of Standards on concrete gaged with a solution of calcium chloride are sufficient grounds for believing that the addition of Cal will not injuriously affect the ultimate strength and integrity of portland cement concrete.

Cost of Road Roller Operation at Los Angeles.—The engineering department of the city of Los Angeles, Calif., owns 17 steam or gas rollers. The daily cost of operation for the year July 1, 1919, to June 30, 1920, on each of the principal classes of work on which they were employed, is given as follows in the last annual report of John A. Griffin, City Engineer:

Cost per day for	Rooting.	Ducing.	Rolling.
5 ton—steam	.....	.....	*$10.5[illegible]
8 ton—gas		....	*9.62
10 ton—steam	[illegible]	$21.65	20.7[illegible]
10 ton—steam	27.[illegible]	27.87	23.02
12 ton—steam	23.6[illegible]	23.06	21.8[illegible]
12 ton—gas	19.8[illegible]	20.97	19.2[illegible]
15 ton—steam	[illegible]	28.1[illegible]	21.11
15 ton—steam	26.0[illegible]	26.33	21.69
17 ton—steam	25.67	26.61	20.3[illegible]

*Includes engineer only, no helper is employed on these rollers as they are used on the construction of asphalt paved surfaces. The figures for all other rollers include the cost for the services of one engineer and one helper.

The above figures are the average for all rollers employed of a given capacity and are the cost per day operated for each group or classe of rollers. The figures for all rollers include the actual expenditures for fuel, expense, and maintenance and for depreciation. The depreciation is figured on an estimated life of 15 years. As not all of the rollers were operated the full year, certain ones were in operation during the period subsequent to the date when a higher wage scale became operative, while others were not. This has resulted in a higher daily cost for such rollers than for those not operated subsequent to that date.

County Highway Contracts in Pennsylvania.—Twenty-seven county road projects, involving the construction of 88.18 miles of highway to cost $4,526,960.72, mostly in Western Pennsylvania, are being supervised by the state highway department, which has approved plan under which the county authorities are proceeding. All of the projects are for modern-typed pavements.

Effect of Quantity Changes on Contractor's Profits*

By WARD L. CHRISTIE

[illegible] Engineer, Associated General Contractors of America

In making a study of highway contracts recently it was found that 14 states in the Union are using Pennsylvania specifications. Some have adopted them without change and a number have combined the two. How much of anything else was included in this borrowing was a natural query from contractors. Nearly 40 states use the time-honored clause that runs something like this:

"Final payment will be on the actual quantities of work done and materials furnished at the unit prices set forth in the contract and no allowance will be made for lower anticipated profits due to any increase or decrease in quantities. The department also reserves the right to omit any item of work contained in the estimate."

For years contractors have been signing such contracts despite the fact that every such reduction or omission constitutes a direct financial loss. The overhead and indirect expense must be distributed to a certain number of units, and if that number is decreased, all expense which is not reduced proportionately stands as a loss of profit.

The extent of the loss which is entailed by reducing quantities is frequently underestimated. This is usually due to lack of properly segregating and studying those costs of a job which are not reduced when the pay units are reduced. In any instance where the total of such costs equals the original possible profit, the profit will be wiped out by a 50 per cent reduction in quantities. If these fixed charges are greater than the original possible profit, a loss of all profit may occur with less than a 50 per cent reduction. On work which requires a great variation of construction to be paid for by a few different units, the profit may readily be wiped out by a reduction of 25 per cent, an amount allowable, without adjustment of the contract price, under some state contracts. A need exists therefore for some simple method of showing the relationship between these reductions and unit prices.

The relation of quantity changes to cost of the work may be generally stated as follows:

1. The unit cost becomes greater at an increasing rate as the original quantities are reduced.

2. The per cent increase in the unit cost caused by any reduction is greater than the per cent decrease caused by a similar addition.

3. The rate of increase or decrease depends upon the amount of fixed charges carried by the work.

What Constitutes Fixed Charges?—By fixed charges in this instance is meant every expense that is independent of the number of units constructed and a part of every expense of the work which is not directly proportional to the number of units. The latter is difficult to estimate because the contractor has no way of checking it. But he knows well enough that scarcely any item of construction expense will be reduced in proportion to a decrease in the pay quantities.

The following is a list of common fixed charges:

1. Camp and Temp. Structures:
   - Material
   - Erecting
   - Moving
2. Auxiliary Work:
   - Water supply
   - Drainage
   - Storage
   - Telephone lines
   - Obstructions
   - Hauling roads
3. Equipment:
   - Loading and unloading
   - Erecting and dismantling
   - Freight and hauling
   - The rental charge (usually)
4. Miscellaneous:
   - Permits
   - Land damages
   - Hardware utensils
   - Rent
   - Special risks

On certain projects, culverts, ditches, catch basins, or any other parts of the construction which do not appear in the contract as pay quantities, may constitute a portion of the fixed charges.

Effect of Quantity Changes on Costs.—For a specific case, the accompanying curves show the effect of these charges on cost and profit, when the original contract quantities are altered. A contract for 100,000 sq. yd. of concrete paving is assumed. The unit price of $3 per square yard is assumed, made up of the following:

---

*From the Bulletin of the Associated General Contractors of America.

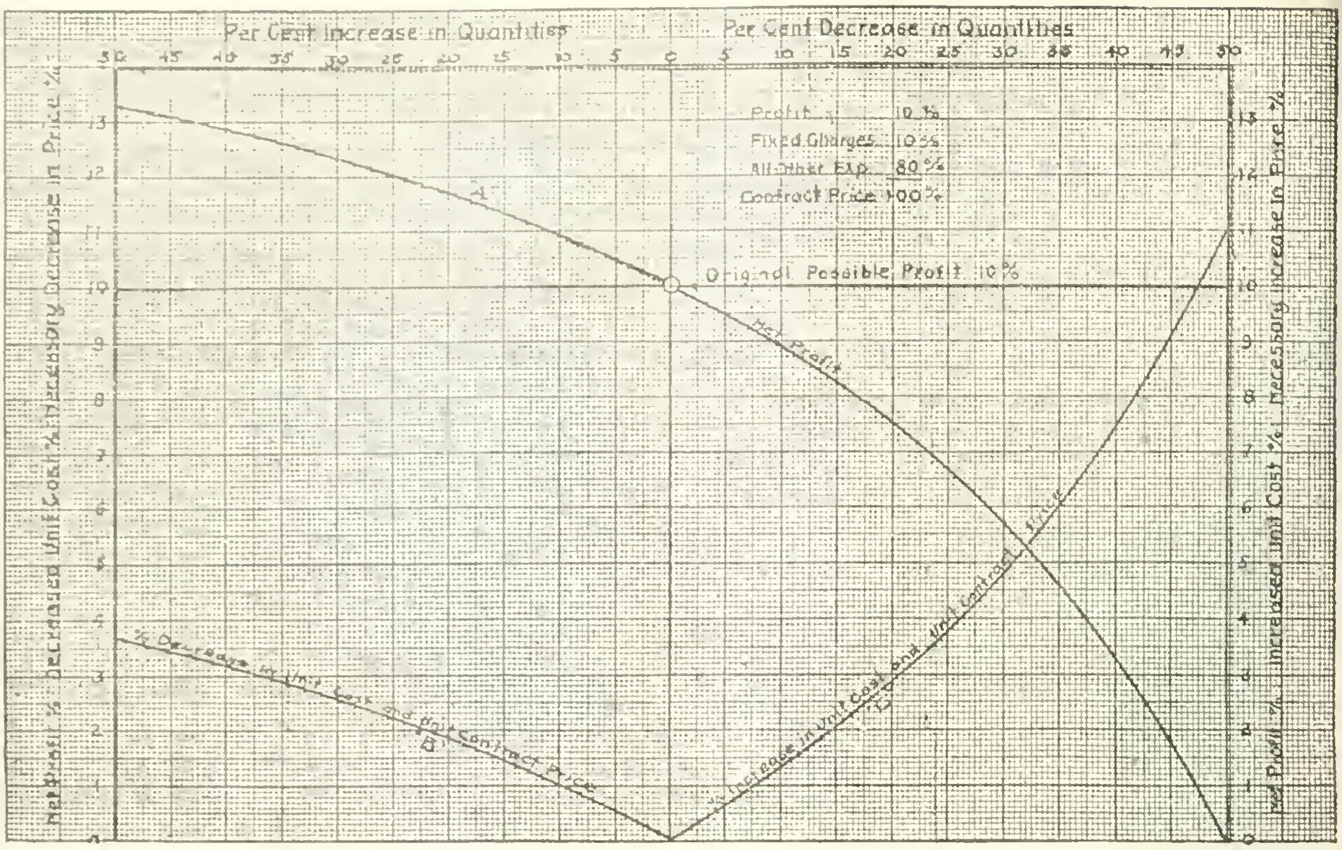


Chart I—Effect on Profit and Cost of Work Resulting from Changing Contract Quality.

CHART I.

	Per cent.
Net profit	10
Fixed charges	10
All other expense	80
Contract price	100

CHART II.

Net profit	10
Fixed charges	20
All other expense	70
Contract price	100

Chart I shows the effect of any addition or deduction up to 50 per cent of the contract, when the fixed charges are low, i. e., 10 per cent. Chart II shows the effect when they are high, i. e., 20 per cent. The item "all other expense" means that portion of the total expense which will vary directly with any change in the revenue producing units. The values for plotting the curves are found as follows:

CURVE A. CONTRACT REDUCED 15 PER CENT.

Original contract—100,000 sq. yd. at $3	$300,000
Net cost of original contract (minus 10 per cent profit)	270,000
Fixed charges—10 per cent of $300,000	30,000
All other expense—80 per cent of $300,000	240,000
Reduced contract—85 per cent of $300,000	255,000

COST OF WORK UNDER REDUCED CONTRACT.

Fixed charges (constant)	$ 30,000
85 per cent of "all other expenses" ($210,000 × .85)	204,000
Net cost of reduced contract (minus profit)	234,000
Contract price ($3.00 × 100,000 × .85)	255,000
Profit ($255,000 — $234,000)	21,000
Percentage of profit ($21,000 ÷ 255,000)	8.2%

CURVE C. CONTRACT REDUCED 15 PER CENT.

Net unit cost of reduced contract ($234,000 ÷ 85,000) per sq. yd.	$2.75
Net unit cost of work for original quantities ($270,000 ÷ 100,000) per sq. yd.	2.70
Increase in unit cost due to 15 per cent reduction in quantities per sq. yd.	.05
Increase in unit cost due to 15 per cent reduction in quantities	1.9%

Curves A, right half, reading up and right, show per cent net profit when quantities are reduced.

Curves A, left half reading up and left show per cent net profit when quantities are increased

Curves B, reading up and left, show (1) per cent decrease in unit cost when quantities are increased and (2) necessary decrease in contract price to maintain original per cent of profit.

Curves C, reading up and right, show (1) increase in unit cost when quantities are reduced and (2) necessary increase in contract price to maintain the original per cent of profit.

For example, after estimating this concrete highway job on a basis of 10 per cent net profit with the fixed charges approximately 20 per cent of the contract amount, Chart II will furnish the information for adjusting the price for any change in the contract quantities. Assuming a 20 per cent reduction in quantities, the following facts are shown by the curves:

1. Reading down from top of the chart under 20 per cent decrease to curve A and then horizontally to the right, the net profit will be 5 per cent instead of 10 per cent.

2. Reading down from the top under 20 per cent decrease to curve C and horizontally to the right, the increase in unit cost will be 5.6 per cent which is also the amount by which the original unit price must be increased to maintain the 10 per cent profit.

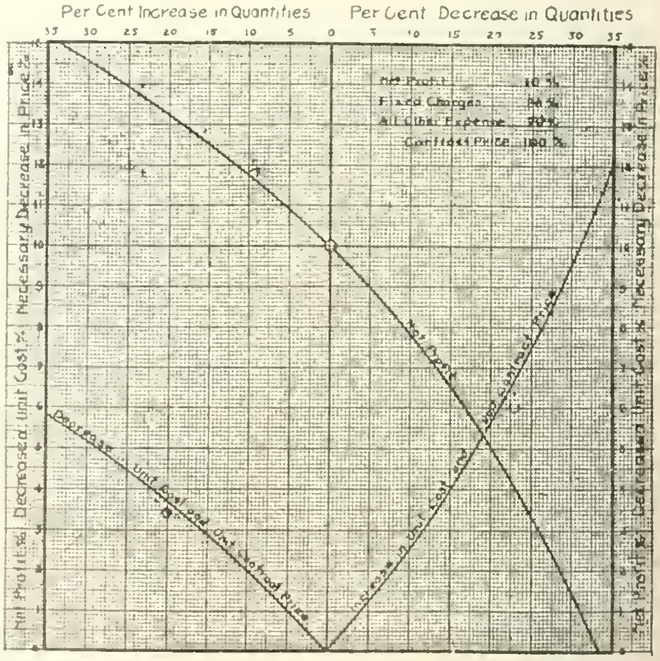


Chart II—Effect on Profit and Cost of Work Produced by Changing Contract Quantities.

For an increase of 20 per cent in quantities, reading down to curve A, then horizontally left, the [illegible] will be 13.2 per cent. Reading down to curve B, the [illegible] decrease in unit cost and the decrease in unit price necessary to maintain the profit at 10 per cent are 3.7 per cent.

The slope of the curves is set by the ratio of fixed charges to profit and the ratio of profit to unit price. These proportions will vary on different contracts, and the amount which a given change in quantities will alter profit varies on different jobs. But if a contract estimate is made in detail and the fixed charges are segregated, the curves for that contract may be readily drawn. By means of these the proper adjustment of price may be determined for any change of quantity in advance.

Suggested Clause for Quantity Charges.—The same analysis is applicable to railroad or other unit price work. Under any contract where indirect expenses must be distributed to certain pay quantities a reduction of such quantities leaves a part of the expense uncovered. To be profitable against this, an analysis should be made of each job and the contract should provide for adjustment upon the basis of that analysis. A clause containing the results of the analysis should be incorporated in the contract in place of the time honored clause providing "no allowance for low or anticipated profits due to any increase or decrease in quantities." Such a clause might read as follows:

"If, by order of The Department, the number of any Pay Units shall be omitted or changed in amount more than 30 per cent payments for every such quantity changed shall be determined by arbitration as hereinafter provided. If any Pay Unit shall be reduced in amount 30 per cent or less, the unit price for every quantity changed shall be increased according to the following schedule:

Decrease in Quantities.	Corresponding Increase of Unit Price.
0% to 10%	[illegible]
10% to 15%	[illegible]
15% to 20%	[illegible]
20% to 25%	[illegible]
25% to 30%	[illegible]

"If the number of any Pay Units shall be increased in amount 30 per cent or less, the unit price for every quantity changed shall be decreased according to the following schedule:

Increase in Quantities.	Corresponding Reduction of Unit Price.
0% to 10%	[illegible]
10% to 15%	[illegible]
15% to 20%	[illegible]
20% to 25%	[illegible]
25% to 30%	[illegible]

Systematic Inspection Cuts Cost of Motor Truck Operation.—Systematic, thorough inspection is essential to economical truck operation, whether 1, 50 or 150 trucks be in service. It cuts maintenance cost and operating expenses, reduces depreciation, increases operating efficiency and "tones up" the driver. An operator of a fleet of nearly 800 trucks recently declared that inspection actually decreased operating expenses by 20 per cent. Some of the better truck makers maintain inspection service of varying degrees of efficiency. If an owner cannot avail himself of this service he should have an expert inspect his trucks at least once a month. A thorough inspection requires at least two hours' time. The inspector should check a printed form report, noting after actual test the condition of the various parts of the motor, governor, radiator, carburetor, ignition system, clutch, grease cups, transmission, steering mechanism, rear axle, chassis, body, cab, brakes, etc. This monthly report constitutes the eyes of the truck owner or fleet manager. It tells him whether the driver is competent, whether the truck is overloaded or otherwise abused. It gives him a check upon his repair service, showing whether it is up to standard and, most important of all, it is the best insurance against possible breakdowns or troubles. It truly is a "stitch in time" policy. Some of the larger fleet owners have their own inspection service highly organized. The inspectors have the power to send a truck to the service shop if they deem it necessary. They are responsible only to the fleet manager, thereby furnishing him with a check upon his maintenance and operating divisions.

The Measure of a Model Paving Program for Typical City of 20,000

An interesting study of the relation between real property values and percentages of paved streets was given by Mr. Maurice B. Greenough, Secretary, National Paving Brick Manufacturers' Association in a paper presented Nov. 15 at the annual convention of the City Managers' Association. Based on data secured from 21 cities, Mr. Greenough has prepared a graph which gives the measure of what a typical city of 20,000 population ought to have and to do in the way of paving. An abstract of the paper follows. The cities considered in the study are given in Table I.

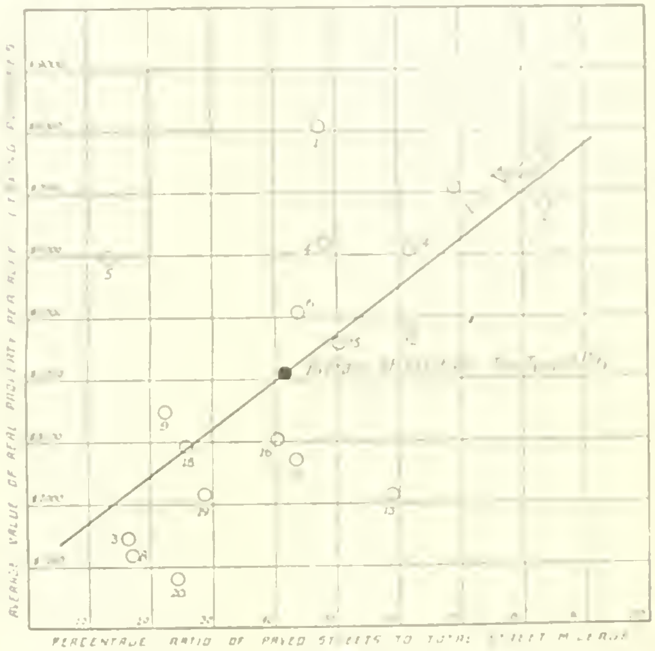


Fig. 1—Relation of Property Value to Paved Streets.

The average population of these cities is 20,232. The area of the typical city is 4,094 acres. The community has 70.7 miles of dedicated streets of which 28.2 miles are paved. The value of real property is $14,025,000.

The variations are very great, however, in the actual values from which the typical averages are derived. A wide range separates extreme, and mean and extreme values, on all points except population. The diverse composition of cities of the same size is strongly emphasized.

TABLE I—SHOWING DATA AND COMPUTATION FOR PER CENT OF PAVED STREETS AND VALUE PER ACRE OF REAL PROPERTY IN 21 CITIES

City	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Marion, O.	71.8	35.0	[illegible]	$23,259,000*	2,899	$8,030
Ann Arbor, Mich.	[illegible]	67.0	[illegible]	[illegible]	[illegible]	[illegible]
Appleton, Wis.	[illegible]	14.8	16.2	[illegible]	1,160	1,142
[illegible], Mass.	42.0	[illegible]	[illegible]	21,754,675	[illegible]	[illegible]
[illegible]	66.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Beloit, Wis.	81.0	25.0	43.6	[illegible]	[illegible]	5,062
Bradford, Pa.	[illegible]	41.0	....	[illegible]	[illegible]	....
[illegible]	[illegible]	[illegible]	16.9	[illegible]	16,000	1,171
[illegible], Pa.	[illegible]	[illegible]	22.2	[illegible]	[illegible]	3,186
[illegible], N. Y.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible], Va.	71.5	[illegible]	[illegible]	[illegible]	[illegible]	7,066
[illegible], O.	[illegible]	[illegible]	61.6	[illegible]	[illegible]	4,790
Freeport, Ill.	[illegible]	41.1	58.6	[illegible]	[illegible]	2,150
[illegible], Ind.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6,059
[illegible] City, Pa.	[illegible]	24.1	50.1	[illegible]	[illegible]	[illegible]
[illegible], N. Y.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3,010
San Bernardino, Cal.	[illegible]	[illegible]	[illegible]	(†)	1,180	....
[illegible], Mo.	[illegible]	32.0	[illegible]	[illegible]	[illegible]	2,928
[illegible], Ill.	[illegible]	18.8	[illegible]	[illegible]	[illegible]	2,113
[illegible], Wis.	[illegible]	14.1	21.1	[illegible]	[illegible]	[illegible]
Yakima, Wash.	[illegible]	[illegible]	25.6	(†)	2,355	.....
Ave. for 18 cities‡	70.7	28.2	41.6	[illegible]	4,094	[illegible]

*Figure for real property value is 75 per cent of total real and personal.

†Not given.

‡Bradford, San Bernardino and Yakima are excluded from the [illegible] because of incomplete data. The averages are therefore shown for 18 cities.

A few illustrations. The minimum real property valuation is $7,175,000 at Sedalia. The maximum[*] is $26,000,000 at Ann Arbor. Sedalia has the least area also, 1,700 acres. Bristol has the largest with 16,000 acres. Carbondale has the lowest total miles of dedicated streets with 35. Bristol, as might be expected, has the highest, with 150. Sedalia leads in density of population with 12.4 persons per acre, and has the least per capita real property valuation, $236. Bristol has the minimum population per acre with 1.4 persons as the figure.

Ann Arbor has the largest per capita real property valuation, $1,300 per person. The typical city has 5.0 persons per acre and a per capita real property value of $692.

A casual comparison might lead us to believe, for instance, that because Beloit has three times the real property valuation of Sedalia, it should have three times as many miles of paved streets. As a matter of fact, Sedalia has 32 miles of paving and Beloit, 35 instead of the 96 the comparison would indicate. This illustration serves no more than to point to the risk of forming unsound conclusion from superficially drawn comparisons.

It does not necessarily follow that because one city of 20,000 inhabitants has 40 miles of paving that any one of as many as ten others ought to have the same number of miles. We must seek farther for a basis of proper comparison. We shall find one in the relations between real property values and the percentage of paved streets. And we shall also find that this proper basis of comparison, at the same time, gives us the measure of what a city of 20,000 population ought to have and to do in the way of paving.

Students of paving economics have long known that land abutting a paved street is worth more per unit of area, other things being equal, than land on an unpaved street. The more paved streets a community has, the higher should be the total real property valuation.

Of course the general level of real property value, from which the paving increment is measured, is not necessarily the same for all cities, even those of the same size, for many complex factors of economic and social significance, of no relation to paving, have to do with the determining of values in any community. But admitting a varying level of values in as many cities as may be named, of the same size, we find that there is a fixed relationship, common to all the cities, which gives us a safe index for comparison.

The Index Evaluated. If we compute the percentage of paved streets for each of the cities which constitute the basis of this inquiry and determine the average value[†] per acre of real property for each city as in Table I, we have the necessary factors. Figure 1 shows the plotting of these co-ordinate points. The index we are seeking is found to be represented by the straight line graph whose equation is:

$$P = \frac{V_R - 1000}{75.2}$$

Where V_R = Average Value of Real Property per Acre and P = The Percentage Ratio of Paved Streets to the total mileage of dedicated streets.

The Practical Use of the Criterion.—The principal uses of this criterion or index are two in number:

First—Any city of 20,000 inhabitants may judge its comparative position with reference to another city of 20,000 in respect to paving improvements.

Second—A means is provided to estimate the amount of new construction, subject to adjustment to fit local conditions, that a city of 20,000 will require in any given period of future tiime.

The first application of the index is largely of general interest, from the standpoint of rivalry. It enables a city to tell whether it is keeping pace, in paving progress, with other cities in the country of equal rank.

The second use of the index is by far the more important. It furnishes a rather definite criterion to guide a city in the fixing of its prospective paving requirements during any coming period of time. Thus by estimating the probable average value of realy property at the end of five years, say, which any city can do with reasonable accuracy, the equation or curve will show the normal per cent of paved streets which the city should possess at the expiration of the period.

To illustrate: Suppose our typical city, which has an average real property value of $4,132 per acre and 41.6 per cent of paved streets, out of a total street mileage of 70.7, estimates that its real property will be worth an average of $4,600 an acre at the end of five years. The city should then have 47.8 per cent of its streets paved, or 33.8 miles. It now has 28.2 miles. Therefore, to keep up to the prevailing practice for cities of 20,000, our typical city must build 1.12 miles of new paving per year for the next five years. Thus by the use of the relation, with due regard to local conditions that may modify the values somewhat, the determination of prospective paving requirements, in terms of totals, is at least partially lifted out of the realms of conjecture.

The following table gives the percentages of paved streets that correspond to each $500—increment in average real property values, according to the relation just derived:

Value.	Per cent.
$1,000	0.0
1,500	6.6
2,000	13.3
2,500	19.9
3,000	26.6
3,500	33.2
4,000	39.9
4,500	46.5
5,000	53.2
5,500	59.8
6,000	66.5
6,500	73.1
7,000	79.8
7,500	86.4
8,000	93.1
8,500	99.7
8,520	100.0

Who Pays for Street Improvements.—The paving problem canot be considered without special consideration of the point of view of the taxpayer. To a large extent the cost falls upon the property owner and he pays most of the bill in direct taxes. A brief review of just what the taxpayer's part is in street improvements in the city of 20,000 is pertinent.

The proportion of the cost of new construction that falls upon abutting property is large but quit variable. No one method is in the majority according to the returns from the 21 cities. The leading method is that whereby the property pays 100 per cent less the cost of intersections—the intersections being paid for out of the general funds of the city. In 62 per cent of the cities, more than 98 per cent of the cost, less intersections, is charged to abutting property. In two instances none of the cost is borne by abutting property. A detailed statement, in order of the proportion paid by property owners, follows:

100 per cent	4 cities
100 per cent less intersections	7 cities
98 per cent less intersections	2 cities
85 per cent	1 city
80 per cent	2 cities
66⅔ per cent	1 city
50 per cent	1 city
33⅓ per cent	1 city
0 per cent	2 cities
Total	21 cities

The various proportions of the cost of reconstruction paid for by abutting property, in order of amounts, is as follows:

100 per cent	3 cities
100 per cent less intersections	2 cities
80 per cent	1 city
50 per cent	3 cities
0 per cent	9 cities
Depending on first cost	1 city
Not reporting	2 cities
Total	21 cities

The entire cost of maintenance and repair is paid out of the general fund in these cities, but derived, nevertheless, from taxation.

Heating Brick for Cold Weather Paving.—In the construction last year of a 4-mile brick pavement in Black Hawk County, Iowa, the work was continued until after cold weather began. In fact, some brick were laid only a few days before Christmas. In cold weather it was found necessary to sprinkle the cement-sand cushion before laying the brick, in order to keep the cushion from freezing. It also became necessary, at times, to heat the brick before applying the asphalt filler. For this purpose a surface heater was used. This consisted of an iron cover about 5 ft. square, the edges fitting down closely over the pavement surface under which gasoline flames burned. The results, according to a paper presented before the Iowa Engineering Society, were satisfactory when the brick were covered only by a light frost or a very light snow, but when the joints were filled with ice, it could not be melted without injuring the brick.

---

[*] The real value at Alliance, while it is higher than at Ann Arbor, is based upon the assumption that real values are about 75 per cent of the total real and personal values. This estimate is approximately correct. It is made necessary because Alliance returned no real property value.

[†] The real property values are as appraised for taxing purposes. The writer recognizes that uniform methods do not prevail for determining these values.

Railway Transportation and Terminals and the City Plan*

By NELSON P. LEWIS
Chief Engineer, Board of Estimate and Apportionment
New York City

In this paper consideration will be devoted almost entirely to transportation by railroad and the need of suitable provision for railway terminals (using the word in its generally accepted sense rather than with its literal meaning), and of the co-ordination of different transportation lines in order that the facilities of all lines may be availed of by the shipper or receiver of goods at a minimum cost, time and inconvenience to them. If a merchant receives goods from several different sections of the country or if a manufacturer wishes to make shipments to as many points, he should not be compelled to go to a different part of the city to receive or deliver freight arriving or leaving by different lines. He should be able to use the nearest and most conveniently located freight station whatever may have been the origin or whatever may be the destination of his goods or by whatever line they may be carried. This is a fundamental economic principle which holds good whether the town be large or small or whether the transportation lines serving it be few or many.

During the boom period of a town's growth every new railway line which seeks an entry is welcomed with open arms and is allowed to come in as it wishes, to cross streets at grade and to establish its terminals where land is cheapest and the cost of construction is lowest. The result will be a number of independent and disconnected freight terminals, subsequent connections between which become increasingly difficult and expensive as the city grows.

If a town is a seaport or on a navigable waterway, little or no thought has heretofore been given to the co-ordination of the shipping and railroad facilities. The fact that they are a single problem has for some years been appreciated in Europe and in South America, as will be seen from a casual examination of the plans of such seaports as London, Liverpool, Hamburg, Rotterdam, Antwerp, Havre, Buenos Ayres and Rio de Janeiro, and even such inland ports as Duisburg-Ruhrort and Frankfort-on-the-Main. But that is too large a subject to discuss in this connection.

Most of our cities were not planned as we now understand the word planning. The site was surveyed when people began to make their homes and establish their business there and series of streets were laid down for the original settlement and its successive additions. If a railroad was already there the streets were quite likely to have been laid out across and parallel with the railroad which may have been left as a conspicuous feature of the main thoroughfare, a condition which often survives for many years, as is the case in Syracuse, N. Y., where the railroad still occupies the surface of an important street, although its removal has long been discussed and many plans have been made to accomplish this result.

Location of Passenger and Freight Terminals. But let us assume that our cities are to be planned or at least their future development is to be guided in an intelligent manner and the blunders due to lack of a proper plan are gradually to be corrected in so far as it is possible to do so. One of the first questions which will present itself is the best location for railroad passenger and freight stations or terminals, as they are commonly called. Should they or should they not be placed as near as possible to the business center? This question was discussed by Col. William J. Wilgus, formerly Chief Engineer and Vice President of the New York Central Ry., in a paper presented at the City Planning Conference held in Cincinnati in April, 1920, and which formed a part of the report of the Special Conference Committee on Railroad Terminals. He states the case so clearly that the writer ventures to quote him at some length, as follows:

> The advantages (of placing them near the business center) are convenience to that portion of the traveling public which can most easily complete its journey on foot, and, in the case of freight, a slight saving in time and expense because of shortness of haul by motor truck between the freight station and the point of origin or destination. The disadvantages are the maintaining for railroad purposes in the midst of the city of vast wastes which block orderly civic expansion and contribute largely to the con- [illegible] of [illegible] [illegible] the [illegible] the [illegible] with the [illegible] practicable [illegible] the [illegible] per [illegible] as [illegible] der- [illegible] treatment [illegible] railroad [illegible] the [illegible] of the city [illegible] considerable [illegible] of the [illegible] the [illegible] of the city [illegible] at [illegible] for the railroad [illegible] with [illegible] grade. [illegible] * * *
>
> In the case of local freight terminals the advantage of having [illegible] well removed from the business center would seem to far outweigh the small advantage of a shortened haul by motor truck. A larger portion of the expense of freight distribution lies [illegible] trucks waiting opportunities for loading and unloading [illegible] terminals [illegible] The [illegible] and [illegible] in a [illegible] great [illegible] instead of continuing the [illegible] of the railroad [illegible] as near as possible to the business center with the attendant high cost of property and of operation [illegible] with congestion and inefficiency, for the sole purpose of shortening the haul [illegible] truck, it would be better to stretch the railroad haul [illegible] then the haul of the motor truck, and place the [illegible] interchange where cheap [illegible] abound.

Col. Wilgus suggests the interconnection of two or more passenger terminals located at points comparatively remote from the business center, such connecting tracks in turn to be brought in close touch with all parts of the city by means of a system of urban rapid transit lines. Similarly it is proposed that freight be moved by electrically operated multiple unit cars of, say, 10 tons' capacity, from transshipment points on the various railroads serving the city through sorting yards and then through freight subways under the city streets to various points where the car bodies could be transferred from the subway vehicles to the chassis of motor trucks for short radius surface distribution. This would remove the unsightly freight terminal yards from the central part of the city to districts given up to industrial development and where they would be in keeping with their surroundings.

Relation of the Railroad to City Street System. The dependence of the city's development and growth upon the railways serving it must be admitted and every opportunity consistent with the orderly expansion of the city and with the health and convenience of its citizens should be given the railroads to render this service. The importance of the railroad must be recognized. It cannot be kept out of sight and it cannot be wished away. Its existence presents some difficult problems, especially in the relation of the railroad to the street system.

Railroads built through thinly settled districts which produce little business for them are obliged to keep their original construction cost down to the lowest possible figure and to provide for betterments from their future earnings, and this policy is often followed even with respect to the portions of their lines entering or passing through urban districts. This means numerous grade crossings, which, of course, must be eliminated, while additional crossings at grade must be prevented. Nearly all states have enacted laws dealing with this problem, forbidding additional crossings and providing for a division of cost of grade separation between the railroad company, the state and the municipality. Work of this kind involves such great expense that it cannot be carried out in a wholesale fashion but must be undertaken progressively. It is a mistake, however, to consider each crossing or each group of crossings as a separate problem. A comprehensive scheme should be worked out in advance, although the execution of the work may be deferred for years. On one portion of the line it will be found better to elevate the railroad and depress the street and in another section it will be found better to carry the streets over the railroad. When the intervening section is taken up, where the railroad passes from cut to fill, it may be found impossible to carry some important streets either over or under the railroad, while, had the problem been studied in a more comprehensive fashion, more satisfactory results could have been attained. Having determined whether the street so as to pass over or under the railroad. In each case, the clearance required for street and for railroad and how much the grade of each is to give way to that of the other (the last often being an especially difficult question to settle), the character of the structures is to be considered.

---

*From a paper presented at the 26th convention of the American Society for Municipal Improvements.

Where the highway is carried over the tracks little of the railroad besides its roadway, sidewalk and protecting railing will be seen and the chief consideration will be adequate capacity and safety, but where the railroad passes over the street the appearance of the structure must be considered. It need not be monumental or imposing, but, on the other hand, a structure which will simply get the tracks across the street and permit traffic to pass under it without regard to its appearance should not be tolerated.

Railroad stations, yes, even freight stations, should be recognized as public buildings and as such they ought to reflect credit upon the city. This is generally recognized in the case of great passenger stations. In architectural design and in the convenience of their internal arrangements some of them leave little to be desired, though they have not the commanding position with respect to the streets approaching them which is found in some European cities.

Fundamental Considerations in Relation of Railroads to City Development.—The Committee on Railroad Terminals of the National Conference on City Planning, already referred to, presented at the Cincinnati Conference certain general considerations which will be repeated as the conclusion of this paper.

United control and operation of all standard railroad lines within the limits of any city, is essential both to the requirements of modern business and to the convenience of the public. It should be brought about with as little delay as possible, at the same time providing opportunities for expansion both of trackage and terminals in connection with a well considered plan of city development. Means should be found and taken for persuading or compelling all railroads entering the city to connect up with such a unified system as the city limits. The entire question of railroad service should be considered as a whole, not with relation to one system or one part of the city only.

The present wasteful and needless duplication of lines and terminals inside of city limits cannot be permitted to continue. Many cities can show millions of dollars spent in unnecessary duplication of passenger stations when the same sums expended in added industrial lines would have increased both the business of the carriers and the prosperity of the city. This is a useless drain on the railroads, resulting in additional cost of operation, for which the public pays. It is a needless inconvenience to the public which can be remedied at comparatively small cost by proper co-operation in planning by both the city and the railroads. Voluntary action on the part of one road is not to be expected and generally impracticable. The city, with the aid of the state or national Government, holds an advantageous position to undertake bringing the railroads together for any intra-city unification.

All shippers within the city should be free from dependence on one road for cars. In some cities shippers now have to maintain needless additional warehouses on a second line in order to insure prompt delivery of cars on the first line. This is a wasteful expense which must be added to the cost of shipping and doing business, particularly where a perishable product is involved.

All spurs and industrial tracks within the city limits should be "common user" tracks, served by a belt line connected with all main lines entering the city, a fair pro rata return being made to the original owner of each line for such use.

Municipal ownership of intra-city lines is probably not necessary, provided there is unified control. Expansion of existing terminal companies to include all lines within city limits is probably the most economical, quickest and easiest method of accomplishing unification in most cities. New trunk lines should be allowed to hook on to the city terminal lines at the city limits at any time in the future. This would provide for competitive lines through the country without cutting the city into further pie-shaped sections or causing further blighted areas to property within a block or two of each side of the railroad right of way through a city, as at present.

Provision of complete modern business facilities is essential to all industries. Railroad service, while important, is not the only one of these facilities necessary. Protected industrial districts or zones appropriately and conveniently situated, free from hampering residential requirements, with wide heavy hauling pavements, high pressure fire protection, extra large sewers for industrial wastes, etc., as well as unlimited spur tracks, are necessary in any city of consequence, and many of the progressive cities of the country have already established such zones. The fullest co-operation between the city and the railroad is necessary to make the facilties in these zones most useful in the development of business. Once such zones are established both railroads and shippers can feel safe in concentrating large investments for permanent ultimate service, not otherwise justified.

One of the greatest opportunities for railroads to cut down expenses and freight rates is by simplification of terminals. On most of the big roads it costs as much to get a car of freight out of the city limits as it does to haul it 250 miles or more on the main line. Some roads report as much as 35 per cent of their total freight cost in handling at terminals (from reports of O. W. R. & N. R. R. to Oregon Public Service Commission). This is by far the biggest single item to the railroads in their cost of doing business. A small saving, therefore, in terminal handling should effect a considerable amount of saving in freight cost and should be welcomed by railroads and shippers alike.

Whatever the origin or destination, a merchant or manufacturer should be able to receive and ship at the freight station which entails the shortest team haul.

Adequate expanded classification and freight yards must be provided in every city as part of its future plan as an adjunct of industrial development. These yards should have long areas uninterrupted by grade crossings preferably located at one side of or on the outskirts of the city, away from the probable expansion of business and main street traffic lines. Main railroad lines should be diverted around the city, and outside the city limits, wherever practicable, so that through freights and other through trains need not pass through the congested parts of the city. In light of the development of modern street transit, consideration should also be given to the possible advantages of relocating main passenger and freight stations away from the congested districts.

In cities which have water-borne commerce, whether coast or inland ports, rail and water terminals should be considered as a single rather than as separate problems; co-ordination of facilities for both methods of transportation should be insisted upon in the interest of the public and of the carriers themselves.

The relation of the railroad to the street system of the city should be carefully worked out. The value of the railroad to the prosperity and the very life of the city should be recognized. Wide heavy hauling pavements to freight terminals, docks and the industrial zones are equally essential and form a natural and important complement to the greatest use of railroad facilities. Direct and amply wide traffic thoroughfares should lead to all principal passenger and freight stations.

The elimination of grade crossings on both steam and electric rapid transit lines is essential to public safety and convenience, to prevent the interruption of traffic and for the proper conduct of business. The problem of grade crossing eliminations should be studied in the most comprehensive way and not in a piece-meal fashion, even though the execution of the work is to be carried out gradually.

The fullest co-operation should be given cities by the railroads in planting and improving the appearance of borders of rights of way, yards, bridges, viaducts, stations and terminals within the city limits. Much of the present damage to adjacent property values and rentals can be done away with in this manner, at reasonably small expense, by closer working together of railroad officials, park boards and other city officers.

Storing Material Prior to Construction.—Iowa contractors this year, states the Service Bulletin of the Iowa State Highway Commission, are having impressed upon them the advisability of erecting great storage piles of material before actually starting the work of construction. There is hardly a firm building in Iowa today that has not been compelled to lay off several days each month for want of material, several having been running "from hand to mouth" every day in the week. Conditions this year have been exceedingly difficult. Contracts were let late and few of the successful bidders had a chance to take advantage of the winter and spring months to collect and store materials. Most of them had to be content with contracts from material companies for regular daily deliveries. In most cases the contracting companies failed to keep up their run of supplies as agreed and the road contractor has in consequence been forced to lay up his crew and wait the arrival of materials. In many cases the eagerness to get going has undoubtedly cost the contractor heavily for it is in the general run of cases less expensive to delay the start than to lay up days at a time with a full crew after the start has been made. Everything indicates that with the increased amount of work that will be in progress next season, the scramble for materials of all kinds will be worse than this season. It would seem that it behooves every contractor to get his season's work lined up and to begin the storage of material just as early as possible.

$1,130,000,000 for New Highway Construction in 1921

According to a bulletin of the Associated General Contractors of America more than a billion dollars will be available for new highway construction in 1921. The following table shows the sources of this fund:

Total federal aid appropriation	$ [illegible]
Forest road appropriation	14,000,000
State bond issues	[illegible]12,000,000
County bond issues	362,000,000
Direct levies and revenue (estimated)	200,000,000
Total	$1,[illegible]94,000,000
Less total projects completed or under construction	26[illegible],000,000
Available for new construction, 1921	$1,130,000,000

The state and county bond issues, the totals of which are given above, are as follows:

STATE BOND ISSUES

1918—(Partly expended)—		Oregon	10,000,000
Illinois	$60,000,000	Colorado	5,000,000
Pennsylvania	5[illegible],000,000	Maryland	3,000,000
1919—(Partly expended)—		Minnesota	75,000,000
California	1[illegible],000,000	West Virginia	50,000,000
Oregon	12,500,000	Missouri	60,000,000
Nevada	1,000,000	Virginia (Legislature to fix)	50,000,000
South Dakota	4,500,000	New Jersey vehicular tunnel	29,000,000
Wyoming	2,800,000		
Maine	10,000,000	Total state bond issues available for 1921	$513,800,000
Michigan	50,000,000		
Utah	4,000,000		
1920—(New appropriations)—			
Alabama	25,000,000		
Idaho	2,000,000		

COUNTY BOND ISSUES, 1920.

Alabama	$ 5,000,000	Nevada	1,200,000
Arizona	8,400,000	New Mexico	200,000
Arkansas	2,400,000	North Carolina	13,609,000
California	24,635,000	Oklahoma	1,158,000
Florida	1,515,000	Oregon	9,696,701
Georgia	15,245,000	Pennsylvania	21,337,553
Indiana	7,373,000	Rhode Island	8,500,000
Illinois	8,862,845	Tennessee	7,185,000
Iowa	18,475,000	Texas	86,023,000
Kansas	50,000	Vermont	2,766,000
Kentucky	1,700,000	Washington	8,225,000
Louisiana	5,850,000	West Virginia	7,039,200
Michigan	2,300,000	Wisconsin	36,525,000
Minnesota	12,800,000	Wyoming	2,800,000
Mississippi	15,773,000		
Missouri	13,504,000	Total county bond issues	$361,971,537
Montana	6,283,000		
Nebraska	3,000,000		

Average Prices on Iowa Road Construction

Average prices for different items of road construction in Iowa prevailing for the 1920 season and based on approximately $8,800,000 worth of contracts are given in a recent Service Bulletin of the Iowa State Highway Commission.

In assembling these data, some contracts entered into late in 1919 have been incorporated and some of the recent contracts that are based on 1921 completion have been eliminated. Also some contracts on force account or day labor basis have not been used. Owing to the fact that new specifications were adopted after some of the season's work was contracted, it has not been possible to obtain, in the case of graveling and tiling, an exact comparable summary of all items, but the following figures are thought, on the whole, to be representative, as based on 1920 construction costs. The data is as follows:

Earth excavation only:
  A total of 357 miles, involving 2,998,7[illegible] cu. yd. at an average price of 57.06 ct. per cu. yd.
Earth excavation incidental to paving:
  A total of 339,657 cu. yd. at an average price of $1.22 per cu. yd.
Concrete paving, exclusive of grading:
  A total of 115.81 miles involving 1,241,015 sq. yd. of Type A paving at an average price of $3.088 per sq. yd.
Brick paving, exclusive of grading:

[illegible] yd.

[illegible]

Research in the Highway Field

The importance of research in future activities in the highway field was pointed out by Mr. Thomas H. MacDonald, Chief U. S. Bureau of Public Roads, in an address Oct. 20 before the Land Grant College Association. He said:

For the next quarter of a century improvement of public highways will be the greatest single public activity. It will require such enormous sums of money that these expenditures should and must rest upon the soundest principles of engineering and economics.

There are many agencies interested in these problems. Their efforts should be correlated into one comprehensive program. It is highly important that, while this program should be pre-conceived as a whole, and each undertaking formed as a component part, the working out of the problems should go forward in such a manner that individual initiative will be encouraged and local conditions will be met.

It must be recognized that while the improvement of highways in the aggregate is of national concern, and has been so recognized by the Federal government in making available large sums for encouraging road building, the important problems of research and investigations are more or less local. The underlying principles of sound construction or maintenance, or of economics, while remaining the same, are subject to an infinite number of variations dependent upon local conditions of topography, geological formations, population densities, development of industries and such modifying circumstances as to render necessary the proper solution of these problems through a decentralized organization. To bring such movement into being on a national basis seems properly to be a function of the National Research Council.

Perhaps there is one master problem which should be solved first as a foundation for all others. This problem is that of highway traffic. We would be on a very much sounder basis now with reference to highway legislation, appropriations and organization were this investigation complete. The matter is of such importance as to demand a comprehensive and accurate study in every state and one which, first of all, well might engage the attention of those agencies which are interested in the fundamentals of knowledge necessary to the carrying out of large public undertakings. This problem has become acute in other countries. It is engaging the attention of both the English and French national departments of highways to the extent that detailed and accurate studies are being undertaken of highway traffic.

Getting Rural Roads Ready for Winter.—Preparation of roads for winter should be in the minds of every county engineer from this time on till the freeze-up, states the Service Bulletin of the Iowa State Highway Commission. Culverts, side ditches and drain outlets should be open that water from the fall rains can get away from the road grade as quickly as possible. The road surface should be kept in a well dragged condition to prevent ruts and pockets in which the water can collect and remain standing. Work on tile drainage planned for this [illegible] should be rushed. Township trustees [illegible] have the reputation of tearing up their roads just before the winter sets in so that the roads may be bad all winter. Usually the money spent on tearing up township roads late in the fall would better be thrown or given away, but where such work is done or is necessary to do, every effort should be made to keep the road smoothed up with drags until the final freeze-up. People who pay the road taxes are entitled to decent roads to travel over and it is up to the road officials to see that they have them in winter as well as in summer.

Asphalt Mixing Plant Maintains High Output

In resurfacing the worn-out pavements in Hackensack, N. J., a mixing plant which produced an average of 1,600 sq. yd. of asphaltic concrete, although rated at 1250 sq. yd. per day, has borne a large part of the burden of operations for the past two seasons.

Resurfacing with asphaltic concrete is the method Hackensack has adopted to improve its old highways. Worn-out macadam or gravel, brick or block pavements are covered with a new wearing surface of metal, mixed with native lake asphalt.

Asphalt Mixing Plant of George M. Brewster at Hackensack, N. J.

A large part of the highway work during the seasons of 1919 and 1920 has been done by George M. Brewster. To maintain the high average the Brewster company has kept its mixing plant going at top speed almost continuously since it was placed in operation in the fall of 1919.

The plant, an Iroquois three-unit, portable type, produced 100,000 sq. yd. between September of last year and the time cold weather forced a shut-down of operations. In two months it produced 90,000 sq. yd. of material, most of which was 2-in. asphaltic concrete. One thousand eight hundred and forty square yards of 2-in. material was the record daily output for the mixing apparatus. The average was 350 sq. yd. in excess of the guaranteed output.

The power unit of the Brewster company mixer is separate from the plant proper. Storage bins, asphalt tanks and heaters and other equipment have been installed adjacent to the plant, which occupies a central location. Motor trucks are employed to convey the paving material from the plant to the scene of operation.

Rebuilding Gravel Road Shoulders Without Destroying Value of Gravel

Rebuilding gravel road shoulders without destroying the gravel by covering it over or mixing it with too much road soil has been very practically solved by County Engineer A. H. Cunningham of Buena Vista County, Iowa, according to a service bulletin of the Iowa State Highway Commission.

Most engineers, when gravel road shoulders need rebuilding or the side ditches need opening and reshaping, send the tractor blade grader outfit to the road with instructions simply to reshape the side ditch and build up the shoulders. The grader man digs his blade into the side ditches just the same as he does when he starts in to blade grade any ungraded road. The dirt is thrown first from the side ditch upon the shoulder then thrown to the center along the loose gravel and upon the top of the undisturbed gravel surfacing. The result is that some of the gravel is covered over and the balance so mixed with road soil as to destroy its value as surfacing gravel.

Cunningham's method is to send his blade first along the shoulder throwing all the gravel that lies there to a point several feet from the shoulder toward the center of the road. Then the blade goes down into the side ditch and opens it up in the regular fashion. The loose soil is then used to build up the shoulder, care being taken not to throw the dirt far enough in to fall upon or mix with the gravel. When the side ditch is opened and the shoulder reshaped to the liking or skill of the blade grader man, he makes another trip down with blade thrown the other way about and throws the gravel back upon the newly built dirt shoulder. The process consists of throwing the gravel out of the way first, then the side ditch is opened up and the shoulder rebuilt. Then the gravel is spread back and trued up. The result is that the gravel is in just about as good condition for packing and resisting traffic wear as it was before the operation started. In the old-fashioned way, the value of the gravel is practically destroyed and only a partial resurfacing with fresh gravel at heavy expense can undo the damage of the road.

Buena Vista County has many miles of gravel and a tractor blade grader outfit is busied the entire season through on this class of work.

Personals

Roger Cassidy has resigned as road engineer of Fleming County, Kentucky.

R. H. Henderson, a farmer, at present mayor of San Angelo, Tex., has been appointed city manager.

R. R. Ress Smith, county surveyor, has been appointed highway engineer of Sonoma County, California.

Julius Adler has been appointed deputy chief of the division of highways of the Bureau of Highways and Street Cleaning of Philadelphia, Pa.

G. C. Massie of Lynchburg, Va., has been elected president of the new state board for the examination and certification of professional engineers, architects and land surveyors, the organization of which was completed Nov. 5.

J. T. Gillespie, engineer in charge of equipment and day labor jobs of the Wisconsin Highway Commission, has resigned and will remove to Chicago, where he has accepted the position of assistant to the president of the Marquette Cement Manufacturing Co.

Obituaries

George M. Ingram, vice-president of Warren Brothers Co., Boston, Mass., died Oct. 28 at his home in Nashville, Tenn. Prior to his association with Warren Brothers Co., which began in 1902, he had organized the Nashville Roofing & Paving Co., from which he withdrew to enter the larger field.

Richard F. Conway, founder of R. F. Conway & Co., contractors, died recently at his home in Chicago. Mr. Conway was 81 years old and had lived in Chicago 65 years. He was born in Ireland. Four years after coming to Chicago, in 1855, he began in the grain business and continued until 1871, when he engaged in contracting. He was president of his company and also of the International Asphalt Co. until he retired.

Arthur E. Hauck, president of the Hauck Mfg. Co., manufacturers of oil burning appliances, kerosene torches, furnaces and forges, Brooklyn, N. Y., died Oct. 30 at his Flatbush home, Brooklyn, N. Y., aged 41. He began his career by learning coppersmithing in Germany. After learning his trade he left his mother country to follow his trade in the navy and shipyards of Belgium, France, and later in England. He arrived in this country when 20 years of age. He had only enough funds left when arriving in Philadelphia to pay for his first night's lodging, but the next day he obtained employment at the Philadelphia navy yards. After working for three years in the navy coppersmithing shops in Philadelphia, Norfolk, Baltimore and Brooklyn, he started in the oil burner business in 1902.

Trade Publications

The following trade publications of interest to engineers and contractors have been issued recently:

Lifting Jacks.—Duff Manufacturing Co., Pittsburgh, Pa. 148-page catalog illustrating and describing the complete line of Duff lifting jacks. It includes jacks of all types used by contractors—track jacks, bridge jacks, pipe-forcing jacks, motor truck jacks and trench braces.

Reioforcing Metal for Concrete Roads.—National Steel Fabric Co., 901 First National Bank Bldg. 40-page handbook containing, in addition to descriptions and illustrations of National road fabric and National curb (bar) reinforcement, numerous tables and data of interest and value to highway engineers and contractors.

Waterworks and Hydraulics Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm 4[illegible]3 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office Room 413 Engineers' Bldg , LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc

Extra postage in Canada, all issues $2.00 any one monthly issue 50c Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., DECEMBER 8, 1920. Number 23.

Where the Coal Goes

The following are the uses to which coal is put in America:

	Pct.
Manufacturing, electric power plants, etc..	35.0
Railway locomotives	25.0
Exports and power for ships	6.0
Power for coal mines	3.5
Coke for blast furnaces	13.0
Gas works	1.0
Domestic uses (heating and cooking)	16.5
Total	100

The Bureau of Mines estimates that from each 2,000 lb. coal in the coal bed, there is developed in the form of mechanical energy available for power purposes the equivalent of the energy of 76 lb. of coal. The losses are as follows:

	Lbs.
Lost in mining (30 per cent)	600
Consumed in mining coal	31
Consumed in transporting coal	82
Lost en route to boiler room	13
Lost in gases going up the stack	446
Lost by radiation	51
Lost in ashpit	51
Lost in converting heat energy into mechanical energy	650
Converted into mechanical energy	76
Total	2,000

More than half this loss can be saved by methods now available. There are numberless small power plants that will eventually be abandoned, and the needed power secured from large central plants, both because of the fuel saving that can be effected and because of the higher load factor (i. e., ratio of average load to peak load).

Fully half the coal used for domestic purposes can be saved by the use of better heat insulators and by judicious firing. The heat insulation of residences has been little considered by architects, and even less attention has been given to the insulation of furnaces, pipes and flues. There are probably not half a dozen architects in America who know the laws of heat transfer, and we doubt whether there is one who could answer offhand a question as to relative conductivity of the different gases that compose the air.

The fact that carbonic acid gas has half the conductivity of nitrogen or oxygen could be made use of in several ways in the design of buildings; but what architect has even suggested the possibility of doing so?

By filling hermetically sealed cans with a granual or fibrous material and carbonic acid gas, a heat insulator can be made that has one-sixth the conductivity of wood, or one-thirtieth that of brick. Double paned windows, having carbonic acid gas between the panes, have one-fifth the conductivity of an ordinary window.

These and similar facts are known to many engineers, but the knowledge is put to little or no use, partly because engineers have, as yet, no effective means of selling their services to the public, and partly because the ignorance of the public is an almost impenetrable barrier to scientific assaults

Pry Not Too Deeply Into Economics

Farmers are demanding governmental aid in "financing their crops" otherwise interpreted as aid in holding back the crops from the markets until a starving public will pay higher prices for food Although there is little likelihood that Congress will grant the sort of "relief" that farmers seek, the agitation in favor of it is disquieting, to say the least It is another illustration of an activity that is intended to enable one class to gain what other classes lose.

In the selfish struggle, not for exlsence but for a greater share of the luxuries, first one class, then another, seeks legislation that will give an advantage. The railway brotherhoods, having won through legislation a big wage increase, next demanded a law that would virtually nationalize the railways. The farmers, having been exempted from the anti-trust provisions of the Sherman law, now seek special extensions of credit through governmental aid. Next the coal miners, following the precedent set in England, may demand nationalization of the coal mines. All this proceeds on the theory that the government is a rich super-parent that can endlessly increase the income of those that enjoy legislative favor. We hear no talk at all of greater general productivity under governmental assistance, but only of greater distribution of wealth to the classes. If all classes are equally "favored," whence are the increased incomes to be derived? But this is prying too deeply into the secrets of economics. Let us rather talk of "Wall Street robbers," of "unearned increments," of "profiteers," and cabbages and kings.

Economic Vicissitudes; Can They Be Reduced?

So long as human wants remain unsatisfied, there can be no such thing as general overproduction. This is true, however, only in special sense of the expression "general overproduction." It does not mean that production in all lines can be expanded indefinitely. There is, for example, limit to the demand for bread.

In discussing social economics, too little attention has been given to the problem of expanding the general demand for goods as rapidly as general productivity increases. It has been taken for granted that general demand will automatically keep pace with, or even outrun general supply, no matter how rapidly the latter may increase. But study of economic history shows that supply frequently outruns effective demand, and that when this occurs on a large scale "hard times" ensue.

Following our civil war, new agricultural lands were opened up for settlement by the building of railroads at a rate that exceeded the growth of population. The results were an excessive supply of railway transportation facilities, and the panic of 1873.

Business men have carefully studied the trend of popular demand, and have even succeeded in changing its trend in various lines to a marked extent; but, on the whole, they have been helpless whenever general demand has suddenly slackened. This is exemplified at the present moment, when a mild "buyers' strike" is occurring.

Fully a quarter of the income of the average American goes for things that he can do without, on a pinch. The extreme flexibility of the general demand is, therefore, a fact that needs consideration. One of the great economic problems, therefore, involves the stabilizing of demand. Some of the most far-sighted of business men believe that stability of prices is one of the essential factors in stabilizing demand. The U. S. Steel Corporation, for example, has long made stable prices a part of its industrial creed. Whatever may be said against associations of manufacturers and farmers who seek to control prices, it is evident that had such control been general, we should not be witnessing the present degree of industrial disturbance.

By providing a currency that is made to decrease when price levels rise, and increase when they fall (which is precisely the opposite of what occurs under our present system) we shall be able to stabilize average prices and thus aid in stabilizing demand. But neither this general price stabilization securable through control of the quantity of money in circulation, nor the special price stabilization securable through industrial and farming associations, will suffice to stabilize general demand in a country that is progressing economically. In such a country the people must be taught progressively to increase their demand for certain classes of service and things such as better teachers, better playgrounds, better residences (owned by the residents), better sanitation, better transportation facilities, etc.

Finally, the people must be taught to maintain a relatively constant demand for each class of services and things; for only in this way can constancy of employment be assured. More than a year ago when Attorney General Palmer was urging all Americans to practice economy, we pointed out the folly of a general acceptance of such advice. It then spelled clearly enough to us what is now printed in every daily paper a shutting down of textile and other factories. But the daily press, echoed and re-echoed Mr. Palmer's advice until the public acted upon it, and with such thoroughness that in many trades not half the workers have a job.

Every society should cultivate stability of demand and a systematic development of increasing demand for the worth while "luxuries," which, when properly appraised, are really necessary for economic progress.

Effect of Pitometer Survey and Meterage on Water Waste at Waltham, Mass.

The average daily water consumption of the city of Waltham, Mass., was over 2,500,000 gal. in 1918; in 1919 it was reduced to a little less than 2,000,000 gal. The daily per capita consumption showed a corresponding decrease from 78.4 to 59.2 gal. The water waste, as measured by the amount drawn from standpipe, during the hours of 1 to 4 a. m., was at the daily rate of 32.6 gal. per capita as compared with 51.6 gal. in 1918.

These desirable results, according to the 1919 report of H. F. Beal, Superintendent of Waterworks, were due to two things: the pitometer survey of the entire distribution system made during May and June, and to the installing of 765 new meters, making the system now 91.2 per cent metered. It is reasonable to expect, states Mr. Beal, that a further decrease in the night loss will be effected when the work of repairing all leaks as located by the pitometer survey is completed—although real satisfactory results cannot be obtained along this line until some measure is adopted to prevent the large waste of water in the eight public watering troughs during the night hours. The average daily consumption for the year of less than 2,000,000 gal. is the lowest since 1906 when the city had but one well and pumping plant. That this average is still lower since the pitometer survey is shown by the following figures:

	Average daily consumption.	Waste rate per day per capita.
1919—Jan. 1 to June 1	2,059,900	36.8
1919—June 1 to Dec. 31	1,876,100	29.6
1919—12 months	1,952,100	32.6
1918—12 months	2,509,900	51.6

The following table shows the increase of meters and the waste as indicated by night loss:

Year.	Per cent of service metered.	Waste rate per capita per day in gals.
1910	12	59.8
1911	16	58.7
1912	18½	61.3
1913	25	62.0
1914	34	51.0
1915	43	45.3
1916	53	43.7
1917	61.7	43.8
1918	77.6	51.6
1919	92.1	32.6

Repairing Leaks in Concrete Water Tanks With Bran

Two sub-surface concrete tanks which had been leaking badly were effectively sealed by the use of bran, according to information furnished The Canadian Engineer by a correspondent. The tanks in question measured 20 ft. in length by 10 ft. wide and 18 ft. in depth. The walls and floors were of reinforced concrete and were 10 in. thick at the top. Plastering of the inside faces of the tanks, which are built into the ground, proved to be of no use, as the water leaking from the outside washed the cement away as soon as it was applied; therefore some other way of making the tanks watertight had to be devised.

The following process was then tried with remarkable success. The tanks were filled with water, and the pressure being greater on the inside faces than the outside, the water ran out through the leaks to quite an extent. Ordinary bran was used as a sealing material. The surface of the water all around the walls for a width of about 1 ft., was covered with bran. This bran floats for some time until it takes a gluish form, when it starts to sink, but very slowly, and in going down following the sides of the walls, the sticking substance is naturally drawn towards the holes into which it deposits itself, being forced in by the pressure of the head of water in the tank.

The operation was repeated until the tanks were made absolutely watertight. They have now been in use since November, 1919, and have not leaked at all since.

The Trend of Prices

To the Editor: Recent events afford a means of verifying your prediction made last spring as to the course of prices. To mention two commodities only, the price of wheat has now fallen to $1.50 a bushel, and cotton to 15 ct. a pound. The New York Times in an editorial says the general level of prices of all commodities has receded about 25 per cent. A comparison of this with the per cent of decline you predicted may be readily made by referring to your article of last April. My impression is that such comparison would show your prediction to have been somewhere near right. Your recent remarks as to "an elastic currency" should receive careful consideration from the law makers (Congressmen).

At the time your April article appeared I offered the criticism that in your formula bank deposits as well as currency should be considered, or that such deposits should be regarded as a substitute, in some ratio (perhaps not dollar for dollar) for currency. There came into my mind at the time a further criticism to which I did not then give utterance and that is that the world-wide conditions as to currency and credit should be considered even in arriving at the prices in any one country, as for example, in this country, America. That is to say, that production in such countries as Russia and Germany, for example, would affect prices the world over and that the matter of whether or not those two countries repudiated their obligations, or in other words, issued fiat currency beyond their ability to redeem would have its effect, and maybe a very large effect, on the productive efficiency in those countries, and hence on the production there, and hence on the prices for many things (such as wheat, for instance) in all the markets of the world. If Argentina has a big wheat crop experience shows that that affects the price of wheat in the United States. To omit Europe now in forecasting economic results is like giving the play Hamlet with the part of Hamlet omitted.

JOHN WILKES,
Civil Engineer.

Nashville, Tenn.

Sanitation and Public Health

The effect of the installation of sewerage, water and main drainage systems on the death rates in New Orleans, La., is well illustrated by a table in the 10th Semi-Annual report of the Sewerage and Water Board covering the period ending Dec. 31, 1919. This table shows the following:

Decade	Death rates— Per 100,000— From malaria	From typhoid.	Per 1,000. From all causes	Average duration of life corresponding to total deaths from all causes
(1) 1880-9	156	21	28.6	35.0
(2) 1890-9	104	39	27.2	36.7
(3) 1900-9.	26	38	22.6	41.2
(4) 1910-19	7	21	20.6	48.5
(5) 1919..	4	13	18.8	53.2

In the decades 1880-9 there was no adequate drainage; vaults, foul gutters and unscreened cisterns everywhere; mosquitoes abundant. During the next 10 years conditions were the same as before, with cesspools increasing and overflowing often into gutters.

From 1900 drainage commenced to improve conditions of soil saturation, and after 1906 sewers also acted to drain the soil and commenced to receive connections.

By 1910 20 per cent of premises were connected with sewers and 38 per cent were connected with waterworks system. Thereafter rapid further connection with both systems and further drainage improvements.

By 1919 practically all well-built areas were well drained; 93 per cent of premises were served by sewers and 96 per cent of premises served by water.

Design of Aspirators for Sterilizing Waters. In the October issue of Mechanical Engineering Mr. A. E. Welden, Chief Engineer, Baltimore County Water & Electric Co., Baltimore, Md., describes the studies and tests made to perfect the design of an aspirator to efficiently unite water and ozone. Public Health Notes summarizes the results as follows: For satisfactory operation the heads of water pumped against should not be reduced much below 12 ft. The length of the jet discharged from the nozzle striking either at the throat or at some point in the diverging tube below the throat gave the best results. The tests indicated the importance of providing not less than 20 per [illegible] at velocity [illegible] testing over that in operation [illegible] to allow for friction in tail pipe and mixer or devices below the throat, including the change in the specific gravity of the mixture of air and water. The final [illegible] were of cast iron enameled with the best possible [illegible] porcelain enamel, but even this is subject to deterioration.

New Method of Applying Alum Directly to Filter Beds at Oshkosh, Wis.

By R. A. MADDOCK

Chemist in Charge, Water Purification Works, Oshkosh, Wis.

When the writer became the chemist in charge of the Oshkosh filtration plant, the plan of applying the alum solution was about the same as that generally employed in any mechanical filtration plant—namely, it was applied to the water just before passing through the vortex whirls so as to give it the necessary mixing with the water. From the vortex whirls the water passes through the aerators to the sedimentation basins. The time required for the water to pass through these basins is about five hours.

While the results obtained from this method were very satisfactory, the writer came to the conclusion that some method should be devised whereby a mat could be obtained on the surface of the sand before a filter was put in operation to avoid wasting a considerable amount of the first water to pass through the filter bed, or allowing a water of an inferior quality to pass into the clear well basin.

After a series of experiments it was found that not only as good, but even a better water could be obtained by using the following method without the aid of any coagulant in the sedimentation basins. However, the natural sedimentation that will take place in a period of five hours should not be overlooked at this point.

After a filter is washed, a measured amount of alum solution of known concentration is applied directly to the water in the filter bed, the water having first been lowered to just below the top of the wash water troughs.

This is allowed to stand long enough to give the alum plenty of time to break up and form a good mat of aluminum hydrate over the entire surface of the sand before the filter is put back in operation.

We have installed perforated pipes over our filter beds through which we apply the alum.

This method has been found to work very satisfactorily. An ordinary water hose and nozzle was the first means of applying the alum solution.

The amount of alum used prior to the installation of this method ranged from 1½ to 3½ grains per gallon of water. On an average, about 800 lb. was used per day. The average for the past two months has been 40 lb. per day.

The saving in money for alum and wash water amounts to about $7,000 per year.

Oshkosh gets its supply of water from Lake Winnebago, which is the largest body of fresh water contained in any one of the United States. It is a very shallow body of water, the greatest depth being about 28 ft.

It has a superabundance of micro-organisms, chiefly diatoms which cause considerable trouble at certain times of the year by forming a crust on the filter beds. This has been overcome to a large extent by breaking the sand bed twice between each wash, effecting a saving in wash water of about 250 per cent.

Certain shifting winds bring practically the entire sewage from the city of Oshkosh, as well as the pollution ordinarily brought down by Fox River to the mouth of our intake.

On the whole the problem has not been an easy one to solve. While it is not believed that this method will produce satisfactory results with a water having a high turbidity or high color, the writer believes that it will prove very effective on any water that has a small or even a moderate amount of suspended or coloring matter.

The writer has thought that it might be worth while to make known the results obtained in Oshkosh, for undoubtedly there are in other places conditions much like those here where the plan might be used advantageously.

Volume Relation of Constant Angle Arch Dams and Gravity Dams

By B. J. JAKOBSEN.
Designing Engineer, San Joaquin Light & Power Corporation, Fresno, Calif.

Below is given a brief discussion of the theory of the constant angle arch dam and of the gravity dam. Formulas are developed which give approximately the yardage required for a constant angle arch dam and for a gravity dam, and comparisons are given of the two types for various sites.

As is shown, there is a certain limiting width of canyon where the constant angle arch dam requires as much concrete as a gravity section. This width increases as the permissible arch stress is increased, and this width also depends upon the general configuration of the site.

Single arch dams are rapidly coming into the more extensive use which they deserve. Only some seven years ago, when the Lake Spaulding Dam was being designed, an eminent engineer, John R. Freeman, recommended an arched gravity type of dam in preference to the constant angle arch dam, in spite of a saving of about 50,000 cu. yd. in favor of the constant angle arch dam. The arched gravity type was actually started and carried up about 60 ft. from the foundation (see Lars R. Jorgensen, "The Constant Angle Arch Dam," American Society of Civil Engineers, Proceedings of May, 1911, plate 11, opposite page 1316). From that point, however, the dam was changed into a constant angle arch dam with arch stresses up to around 300 lb. per square inch, and the gravity principle was given up entirely. I do not know what caused this sudden change of heart, but perhaps the tight money market was a very important factor.

The single arch type of dam has the advantage over the gravity dam in that it can be designed so as to utilize the strength of the concrete, while a gravity dam cannot, since its maximum stress depends solely upon its height. In a dam 100 ft. high the maximum stress at the extreme fibers is 104 lb. per square inch, on the supposition that concrete weighs 150 lb. per cubic foot, and that no tension is allowed (see formula below). In a gravity dam 200 ft. high the maximum stress is just twice that in a 100-ft. dam, or 208 lb. per square inch. A gravity dam therefore cannot benefit from the better grade of concrete which we are bound to have in the future, while an arched dam can.

From recent tests* we know that the strength of concrete is very much affected by the amount of mixing water used, and as contractors and construction engineers learn to make better concrete and begin to understand the enormous monetary benefit derivable from a close supervision of the making of concrete, arched stresses several times higher than those of today (around 300 lb. per square inch) will no doubt be used. This will still further enhance the advantages which the single arch dam possesses over the gravity type.

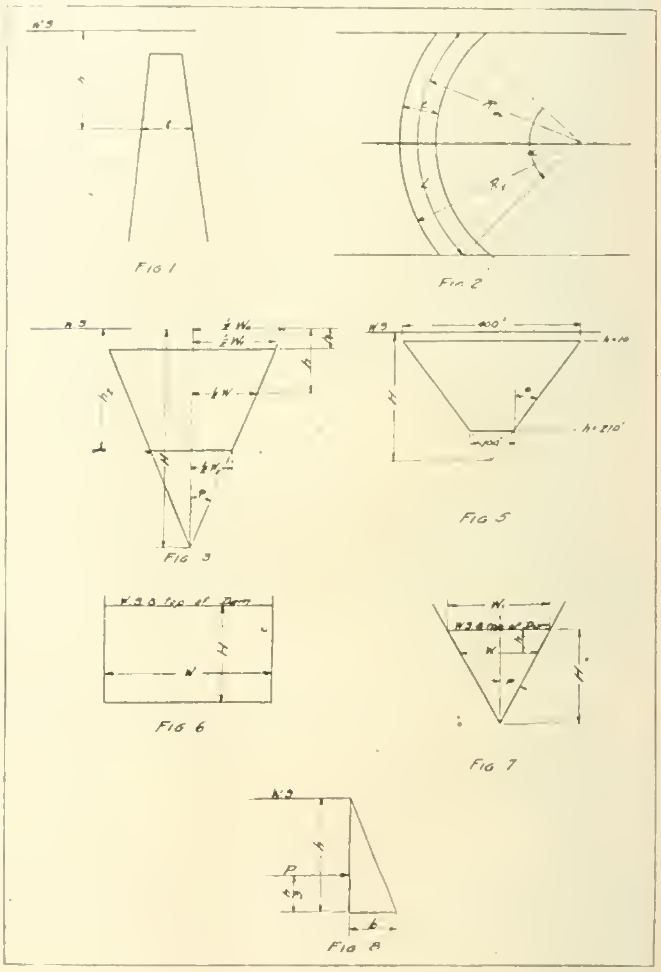
It is common practice in specifications for dams to specify how much cement shall go into each cubic yard of aggregates, and much less common to specify how much water shall go in. This is generally decided by some foreman, notwithstanding the fact that the more water there is put in, the more cement must be put in in order to obtain concrete of a certain strength.

Under existing conditions, engineers designing dams naturally hesitate to increase the stresses, as they have no guaranty that first class concrete will go into the dam, since the men directly in charge of the preparation of the concrete are often wholly ignorant of scientific concrete mixing.

Under a contract, the contractor should not be required to put in a certain mix of concrete, but should be required to furnish a concrete of a given strength. If he does not know how to make good concrete, he evidently lacks one of the most important qualifications for concrete building. This of course does not apply to gravity dams, since in these weight only is involved, and in any but very tall gravity dams any ordinary concrete is sufficiently strong.

Regarding safety, I believe any engineer who has studied the two types of dam will prefer the single arch dam to the gravity dam at the same cost, and it should not be overlooked that it is generally easy to make certain that the canyon sides of a dam site are suitable for an arch dam without doing much work, while the same cannot be said for the foundation for a gravity dam, especially if a considerable amount of water passes the site.

The following discussion is necessarily approximate only, and whether a constant angle arch dam or a gravity dam or some other type of dam should be finally chosen for a given site, must be worked out carefully in each case, but the following formulas will give some help in deciding in a preliminary way.



Figs. 1 to 8.

The main aim of engineers should be to bring down the cost of engineering structures. With the increased cost of labor and materials, the engineer must use more skill and forethought in designing his structures. This will permit of better utilization of materials and the use of a lower coefficient of safety, which to a large extent is a coefficient of inconsistency and ignorance. If the designing engineer can be sure of a uniformly high grade of concrete, the cost of many important structures can be cut very materially; and it is almost as expensive to make poor concrete as it is to make good concrete.

In the following the simple Rankine formula has been used for calculating the stress in a single arch dam, and the effect of cantilever action of the dam has been neglected. This is on the safe side and in the writer's opinion it is not possible to calculate the cantilever deflection of a dam because this involves the variability of the modulus of elasticity, lateral yielding of the concrete, yielding of foundation and abutments, swelling of upstream part of the dam due to wetting, etc. See the writer's discussion of Mr Noetzli's paper, "Gravity and Arch Action of Curved Dams," before the American Society of Civil Engineers.

---

*See L. N. Edwards, "The Effects of Grading of Sands and Consistency of Mix Upon the Strength of Plain and Reinforced Concrete," read before the American Society for Testing Materials, June [illegible], 1917; Duff A. Abrams' "The Effect of Curing Condition on the Wear and Strength of Concrete," Bulletin No. 2, Structural Materials Research Laboratory, Lewis Institute, Chicago; "Some Theoretical Studies on Proportioning Concrete by the Method of Surface Area of Aggregates," by R. B. Young, Proceedings of American Society for Testing Materials, Vol. 19, Part II, 1919.

Computations for Single Arch Dams:

Let t = thickness of dam in feet, h ft below high water elevation:

h = head of water in ft acting on segment of thickness t ft. h ft. below water surface

R_u = upstream radius in ft. of segment h ft below water surface.

R_{av} = mean radius in ft of segment

s = compressive stress in pounds per square inch due to arch action in segment h ft below the water surface.

If it be assumed that the force of the water acting upon the upstream face of the dam is resisted by a compressive stress s uniformly distributed through the vertical area of the segment, then:

$$t = 0.434\,h\,R_u/s \text{ ft} \qquad (1)$$

This is the formula commonly used and is due to Rankine. It is the formula given by Mr. L. R Jorgensen in his paper, "The Constant Angle Arch Dam," in the American Society of Civil Engineers' Proceedings of May, 1914, page 1288.

The true distribution of stresses in an arched dam is extremely complicated, but formula (1) gives values which are nearly correct, especially since in most cases in practical dam design R_u will be large in proportion to the thickness t.

Area of a horizontal arch segment:

For any segment of an arch as shown in Fig 2, the area h ft. below the water surface is:

$$A = L\,t \qquad (2)$$

If W is the width of the canyon h ft. below the water surface, we have from Fig 2—

$$\sin\left(\frac{\alpha}{2}\right) = W/2R \qquad (3)$$

and

$$L = \alpha R_{av} \qquad (4)$$

Combining equations (3) and (4)

$$L = \alpha W/2\sin\left(\frac{\alpha}{2}\right) \qquad (5)$$

For the upstream radius we have from Fig 2

$$R_u = R + \frac{t}{2} \qquad (6)$$

ENGR CONTR—2-X

Substituting in equation (6) for R_{av} its value from equation (3) and for t its value from equation (1):

$$R_u = \frac{W}{2\sin(\alpha/2)\,(1 - 0.217\,h/s)} \qquad (7)$$

If this value for the upstream radius be substituted in equation (1), we get the thickness of the segment under a head of h ft. expressed as a function of W, h and α.

$$t = \frac{0.217\,h\,W}{\sin(\alpha/2)\,(s - 0.217\,h)} \text{ ft.} \qquad (8)$$

The area of the segment is A = L t; substituting the value of L from equation (5) and the value of t from equation (8) and arranging, the area of a segment of a single arch dam is:

$$A = \frac{0.109\,\alpha\,h\,W^2}{\sin^2(\alpha/2)\,(s - 0.217\,h)} \text{ sq. ft} \qquad (9)$$

In order to show how the area of a segment varies with the angle α, let, in equation (9) W = 100'; h = 100' and s = 250 lb. per square inch, and let the angle α vary from 60° to 160°. Then from equations (9), (7) and (8).

$$A = 7{,}635\,\alpha/\sin^2(\alpha/2) \text{ sq. ft.}$$

$$R_u = 219/\sin(\alpha/2) \text{ ft., and}$$

$$t = 38/\sin(\alpha/2) \text{ ft}$$

TABLE 1.

α°	α	$\sin\frac{\alpha}{2}$	A	A in %	R_u	t	t in %
60	1.047	0.5	31,950	151.5	438	76.0	184.2
80	1.396	0.643	25,600	121.2	341	59.2	143.5
100	1.745	0.766	22,600	107.2	286	49.6	120.3
120	2.094	0.866	21,300	101	253	43.9	106.3
134	2.340	0.921	21,100	100	238	41.3	100
140	2.444	0.940	21,200	100.5	233	40.5	98.1
160	2.793	0.985	22,100	106	222	38.6	93.6

In Fig. 4 the area of the segment and the thickness have been plotted in per cent of their value for a central angle of 134° and as a function of the central angle α. It is seen that the area is a minimum for a central angle of about 134°.

This may also be shown analytically. The value of α which gives the least area is found by differentiating equation (9) and equating the differential coefficient to zero

$$dA/d\alpha = 0 \qquad (10)$$

Since W, h and s are constants for any segment of a given width under a given head and with a given stress we have

$$dA/d\alpha = d(\alpha/\sin^2(\alpha/2))/d\alpha = \frac{\sin^2(\alpha/2) - \alpha\sin(\alpha/2)\cos(\alpha/2)}{\sin^4(\alpha/2)}$$

Since $\sin^4(\alpha/2)$ cannot equal infinity it follows that the numerator must equal zero. Evaluating and arranging

$$tg(\alpha/2) = \alpha/2$$

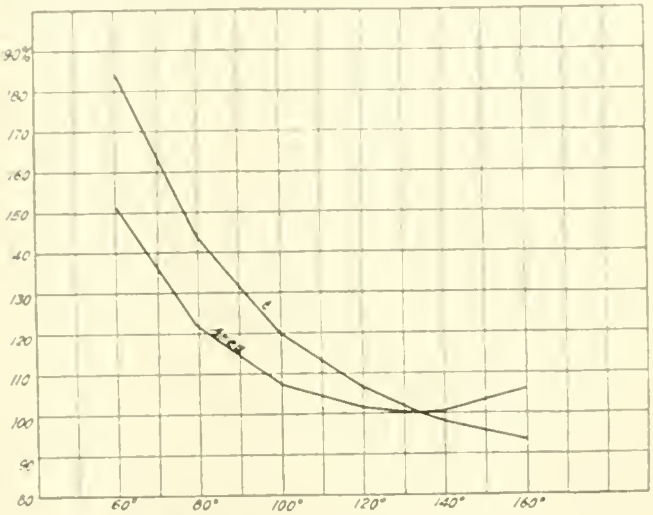
or $\qquad (11)$

$$\alpha = 133°\ 34'$$

Substituting this in equation (9) gives the area of a constant angle arch segment of width W and under a head h ft

$$A = 0.3\,h\,W^2/(s - 0.217\,h) \text{ sq. ft} \qquad (12)$$

In practice it will not generally be possible to maintain a constant angle, which is necessary to give the absolute minimum volume. Inspection of Fig. 4 shows, however, that considerable variation of the angle below or above 133° 34' will not affect the volume of the dam materially. By careful design the angle can generally be maintained quite close to 120° for that part of the dam which takes the bulk of the concrete. The dam as designed in practice will not have a constant angle, but a variable radius and only at the ideal dam site will the angle be constant and equal to 133° 34'.



Variation in Area and Thickness of Arch Segment for Various Values of α

Fig. 4.

By selecting the central angle 120° instead of 134° less than 1 per cent of additional area is required while the thickness of the arch is increased by 6.3 per cent. If the angle be made 120° and the volume be not increased, the stress will be increased approximately 1 per cent, since from equation (9) with constant W and h, s would vary practically as A does, when the central angle is changed.

Formula (1) for determining the thickness of section, takes no account of the length of the arch or the ratio of thickness to length. In a theoretically correct formula this ratio would no doubt enter in and most engineers would feel justified in allowing a higher stress on a short thick arch than on a long and thin arch. The fact that the segment is part of a rigid body and is restrained from yielding in a direction perpendicular to the force s is of course of very great value.

Example: In order to obtain an idea of what saving is effected by the constant angle principle, suppose the characteristics of the dam site to be as shown in Fig 5 and that the two dams are to be designed for a maximum water surface 10 ft. above the crest of the dam. The values of W corresponding to h can be taken from the figure and formula (12) gives the area for the constant angle arch. The area for the constant radius dam can be calculated from equations (7) and (9). The segments are taken as 20 ft. in height and s = 300 lb. per square inch. By selecting the central angle at the top for the constant radius dam as large as possible the volume will generally be a minimum. In this case $\alpha = 142$ was selected for $h = 20$ ft. How large the central angle at the top can be made will of course depend upon the configuration of the site. The result of the computations are given in Table II:

TABLE II.

h.	W.	Volume for constant angle arch dam	Constant radius dam α	Volume
[illegible]	385	60,160	12	60,270
40	355	103,8[illegible]	[illegible]	104,300
[illegible]	325	132,500	1[illegible]	136,900
[illegible]	295	147,700		160,000
100	265	151,400	88	169,700
120	235	145,100	[illegible]	181,000
140	205	130,900	67	180,500
160	175	110,800	58	174,900
180	145	87,000	48	161,500
[illegible]	115	60,400	8	110,300
		1,129,760		1,469,370

This shows a saving of 23.1 per cent in favor of the constant angle arch dam. This saving will be more marked as the canyon approached a true V shape. For vertical canyon walls, the two dams are nearly alike. The thickness at the bottom of the two dams is 19.4 ft. and 55 ft., respectively, while the thickness of a gravity dam is 136 ft. This gives an idea of the relative amount of excavation involved with the three types of dam.

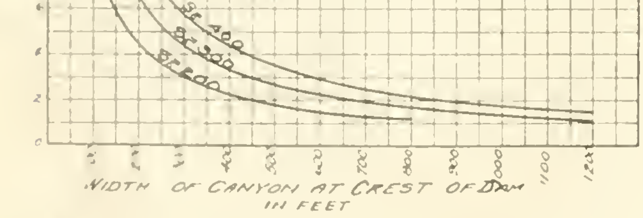
The saving of 23.1 per cent is not generally obtainable, because the central angle cannot be kept constant and also some saving might be effected in the constant radius dam by making the central angle at the top larger and taking advantage of short gravity sections at each end.

The table shows plainly the larger volume which goes with the smaller central angles.

The saving effected by the constant angle arch principle expressed in per cent of dam volume, is independent of the stress s, as may be seen by comparing equations (9) and (12). But the saving in cubic yards will increase when s decreases.

The saving afforded by the constant angle arch principle varies, depending upon the configuration of the site. In some cases it may be as high as 50 per cent, and for vertical canyon walls it is 0.

If the dam site shown in Fig. 5 had been twice as high, but 400 ft. wide at the top and 100 ft. wide at the bottom, as shown, each segment would be 40 ft. instead of 20 ft., and the head "h" would be twice what it was in Table II. Therefore, each segment of both dams would be four times larger than shown in Table II, but the saving in per cent would be the same.



Ratio of Volume of Gravity Dam to Constant Angle Arch Dam for V-Shaped Canyon.

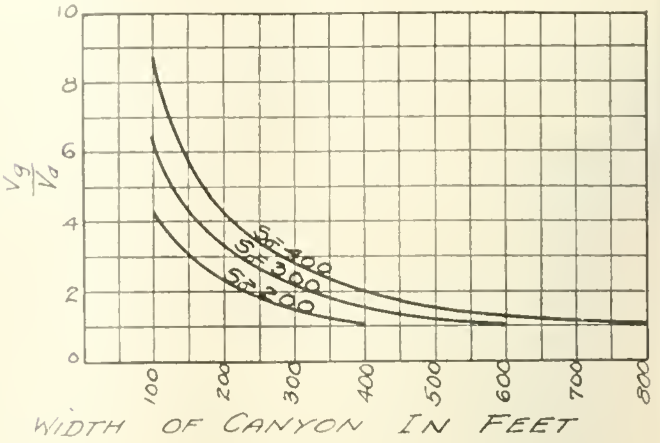
Volume of Constant Angle Arch Dam.—Equation (12) may be simplified by allowing the stress s to increase with h. In such manner that

$$s = 0.217\ h\ s_0 \qquad \text{.....(13)}$$

where s_0 is the minimum stress to be used in the dam. This is permissible because the concrete h ft. below the water surface is stressed in compression in a vertical direction due to the weight of the concrete above it. On the upstream face the concrete is also stressed in a horizontal direction due to the water pressure on the face of the dam and this concrete is therefore stressed in compression in three planes each perpendicular upon the others. And Poisson's ratio for concrete is not far from 0.217. Then equation (12) becomes:

$$V = 0.3\ h\ W^2/s_0 \qquad \text{.....(14)}$$

In order to compare the volume of a constant angle arch dam with that of a gravity dam, the volume of a constant angle arch dam has been derived for a V-shaped canyon and for a canyon with vertical sides, since these two shapes may be considered the extremes between which most dam sites will lie.



Ratio of Volume of Gravity Dam to Constant Angle Arch Dam for Vertical Canyon Wall.

A. Vertical Canyon Walls. Fig. 6. W is constant; then the volume of a dam of height H is:

$$V_1 = \int_0^H \frac{0.3\ W^2\ h\,dh}{s_0} = 0.15\ W^2\ H^2/s_0 \text{ cu. ft. .....(15)}$$

B. V-shaped Canyon. Fig. 7. The relation between W and h is as follows:

$(H - h)/H = W/W_1$ or

$h = H - H\ W/W_1$ and $dh = -H\,dW/W_1$ ....(16)

Introducing this into equation (14), the volume is:

$$V = \int_0^{W_1} \frac{0.3\ W^2}{s_0}(H - H\ W/W_1)(-H\,dW/W_1) \text{ or}$$

$$V = H^2W_1^2/40\ s_0 \text{ cu. ft. .....(17)}$$

The volume of a constant angle arch dam to fit a canyon as shown in Fig. 3 may also be expressed in a simple formula, and may sometimes be of assistance in estimaitng roughly the yardage required for a given site, since nearly all sites met with in practice are a modification of Fig. 3.

The relation between W, h and ϕ is as follows, when the water surface and the top of the dam coincide, i. e., $h_1 = 0$ in Fig. 3.

$tg(\phi) = W_1/2H = W/2(H - h)$ and

$h = H - W/2\ tg(\phi)$ and $dh = -dW/2\ tg(\phi)$ ......(18a)

Introducing this into equation (14), we have for the volume:

$$V = \int_{W_1}^{W_2} \frac{0.3\ W^2}{2\ S_0\ tg(\phi)}(H - W/2\ tg(\phi))\,dW$$

$$\left.\begin{aligned} V &= \frac{0.05}{S_0\ tg(\phi)} W^3 (H - W/2.67\ tg(\phi)) \Big|_{W_1}^{W_2} \text{ cu. ft.} \\ \text{or } V &= \frac{0.1\ H^2W^3}{s_0\ W_1}\left(1 - 0.75\frac{W}{W_1}\right)\Big|_{W_1}^{W_2} \text{ cu. ft. .....} \end{aligned}\right\} (18)$$

If the crest of the dam is h_1 feet below the water surface, as shown in Fig. 3, then H in equation (18) must be given the value shown in Fig. 3, since h, which measures the water pressure on each segment, is increased by the amount h_1, as may be seen from equation (18a). Nothing else is changed in equation (18). The corresponding changes can easily be made in equations (15) and (17) if desired.

It should be noted that the above formulae give minimum values for the volumes and that in practice it is not generally feasible to maintain the central angle at 134° and therefore the actual volume will be somewhat larger than the theoretical minimum. The magnitude of this excess depends upon the configuration of the dam site and upon the skill of the designer.

Gravity Dams.—The force acting upon a vertical strip of dam h ft. high and 1 ft. wide is, see Fig. 8:

$P = 31.2\ h^2$ lb. .... (19)

and the moment with reference to the base resulting from this force, is

$M = P\ h/3$ ft. lb. .... (20)

The resulting tension h ft. below the water surface at the upstream face of the dam due to the force P of the water and on the supposition that the concrete possesses no weight

$s = 6M/b^2 = 62.4\ h\left(\frac{h}{b}\right)^2$ lb. sq. ft. or

$= 0.434\ h\left(\frac{h}{b}\right)^2$ lb. per square inch .... (21)

where b is the width of base h ft. below the water surface.

The compression in the concrete at this place due to the weight of the concrete above is

$q = 0.434\ a\ h$ lb. per square inch .... (22)

where a equals the weight of the material of which the dam is built divided by the weight of an equal volume of water. If there is to be no tension

$q = s$ or $\frac{b}{h} = \frac{1}{\sqrt{a}}$ .... (23)

s is the foundation pressure for the toe of the dam when the reservoir is full and when h and b in equation (21) are the dimensions at the base of the dam; q is the foundation pressure for the heel of the dam when the reservoir is empty. If q = s then the resultant will lie exactly on the middle third point. If q > s the resultant lies inside the middle third and then b will be correspondingly greater than equation (23) indicates.

For concrete weighing 150 lb. per cubic foot a = 2.4 and

$b = 0.646\ h$ .... (24)

Area of a Horizontal Segment. The area of a segment of gravity dam h ft. below the top of the dam (which coincides with the maximum water surface) is:

$A = 0.646\ h\ W$ sq. ft. .... (25)

Volume of Gravity Dam. The above formula for the area of a segment of gravity dam may now be applied to three typical dam sites as was done above for the constant angle arch dam.

A. Vertical Canyon Walls. Fig. 6. W is constant, then the volume of a dam of height H is:

$$V_g = \int_0^H 0.646\ W\ h\ dh = 0.323\ WH^2 \text{ cu. ft.} \quad \ldots\ldots (26)$$

B. V-shaped Canyon. Fig. 7. The relation between W and h is as given above in equation (16). The volume is then:

$$V_g = \int_0^{W_1} 0.646\ W(H - H\ W/W_1)H\,dW/W_1$$

$$V_g = 0.108\ H^2W_1 \text{ cu. ft.} \quad \ldots\ldots (27)$$

C. Volume for a site as shown in Fig. 3, with the water surface and the crest of the dam coinciding. The relation between h, H and W are as given above in equation (18a). The volume is then:

$$V_g = \frac{0.323}{tg(\phi)}\int_{W_1}^{W_2}(W\ H - W^2/2\ tg(\phi))\ dW$$

$$V_g = \frac{0.162}{tg(\phi)}\left|W^2(H - W/3\ tg(\phi))\right|_{W_1}^{W} \text{ cu. ft.} \quad \ldots\ldots (28)$$

Volume Ratio of Gravity and Constant Angle Arch Dams.

A. Vertical Canyon Walls. Fig. 6.

$V_a = 0.15\ W^2H^2/s$ cu. ft. .... (15)

$V_g = 0.323\ W\ H^2$ cu. ft. .... (26)

In this case both dams increase their volume as the square of their height. The arch dam increases its volume with the square of the canyon width while the gravity dam increases its volume proportional to the first power of W. The ratio of volume is:

$V_g/V_a = 2.15\ s/W$ .... (29)

For narrow vertical canyons and no matter what the height, the gravity dam requires much more concrete. As the width of the canyon increases the constant angle arch volume increases faster than the volume of the gravity dam. The two volumes are alike when (29) is unity, or

$W = 2.15\ s$ .... (30)

The value of s will lie between 200 and 800 lb. per square inch. As contractors and construction engineers become educated to the importance of making good concrete the permissible stress on arches will increase. For relatively short and heavy arches a stress of 800 lb. per square inch is very conservative in view of the fact that the segments are supported laterally by each other.

B. V-shaped canyon. Fig. 7.

$V_a = H^2W_1^2/10\ s$ cu. ft. .... (17)

$V_g = 0.108\ H^2W_1$ cu. ft. .... (27)

Both dams increase their volume in proportion to the square of the height. The constant angle arch dam's volume is proportional to the square of the canyon width and the gravity dam's volume is proportional to the first power of W. The ratio of volumes is

$V_g/V_a = 4.32\ s/W_1$ .... (31)

And these two volumes are alike when

$W_1 = 4.32\ s$ .... (32)

In case of a V-shaped canyon the width must be twice that of a canyon with vertical sides before the volumes of the two types of dams are equal.

For the dam shown in Fig. 5, but with the crest of dam coinciding with the water surface, we have for the gravity dam:

$V_g = V_1 - V_2 = 3,100,000 - 483,000 = 2,617,000$ cu. ft. and for the arch dam:

$V_a = V_1 - V_2 = 952,000 - 48,000 = 904,000$ cu. ft. This gives a ratio of $V_g/V_a = 2.9$.

The value of $s_o = 300$ lb. per square inch, which was used for the arch dam, is very conservative for a high grade of concrete. It could safely be doubled towards the bottom where the arch is relatively thick and short.

Cost of Laying Water Mains at Hartford, Conn.—During the 1919 season the Water Commissioners of Hartford, Conn., laid 37,400 ft. of 4-in. to 42-in. main pipe. Of this, 3,231 ft. were renewals and 34,166 ft. were extensions. The force employed consisted of two foremen and a total average gang of 42 men. The following table from the report of the Commissioners for the year ending March 1, 1920, shows the average costs of main pipe work in 1919, and a comparison with previous years:

		Cost per linear foot						
		1919						
Size, inches.	Length laid 1919, feet.	Labor	Mat'l incl. transportation.	Total.	1918 Total.	1917. Total.	1916. Total	1915 Total
4	411	$0.74	$1.06	$1.80	$....	$1.20	$0.81	$....
6	3,560	0.88	1.72	2.60	2.48	....	1.46	1.26
8	10,160	0.92	2.20	3.12	3.15	2.41	1.66	1.62
10	3,773	1.31	3.22	4.53	*4.72	3.00	2.15	1.93
12	539	1.72	3.71	5.43	4.15	4.12	2.82	2.43
16	547	1.38	8.17	†9.55	6.17	4.92	4.58	

*Includes some macadam. †Two special bridge crossings.

Labor .... $3.55 for eight hours
Pipe .... 60.00 per ton
Specials .... 110.00 per ton
Lead .... 0.09 per pound
No overhead charges.

The prices applicable to the average condition on which the above table is based were:

On March 1, 1920, minimum rates of labor were $4.55 per day of 8 hours and cast-iron pipe cost $72 per ton.

How Often Do Engineers Move?—The records of the National Headquarters of the American Association of Engineers for the month of November indicate that about four engineers out of ten change their addresses in the course of a year. During that month there were 802 changes of address made in the records of the association. This was an average of 32 for each working day. The least number of changes made on any one day was 12; the greatest, 66. Based on an average membership of 22,500 (approximate) for November, the monthly changes in address amounted to 3½ per cent—or 42 per cent a year. Continuation of these records will enable the association to determine whether these figures for November are accurate indicators of changes in address in the course of a year.

Methods of Preventing and Removing Moss from Irrigation Canals

Useful information in the [illegible] by managers of various projects of the [illegible] Service is given by Mr. Geo. E. Stratton, [illegible] Manager, Milk River Project, in the November [illegible] Record, to which we are indebted for the following:

Muddy Water. On some projects [illegible] muddy water has been turned into the canals in [illegible] that this water would kill the moss, but where [illegible] period of two or three weeks especially for this purpose [illegible] did not produce the required result. It may be that [illegible] water was run at all times in the canals the moss would not have an opportunity to start, or it is possible that if the muddy water was turned into the canals just at the right time, probably at the time the moss began to grow, and was kept in the canals long enough the moss might be killed, but it does not appear to be a fact that the use of muddy water for a period of only two or three weeks will kill for the season. In any event, the use of muddy water to prevent this growth can not ordinarily be controlled at choice, as the operating force is usually obliged to take the water that is available whether muddy or clear. It might in some cases be possible to roil the water artificially. Probably this could be done most conveniently by the use of a hydraulic giant sluicing sediment into the canal, but this would usually be objectionable for several reasons. On the Milk River Project the water during the greater part of the irrigation season is very clear, so that there has been no opportunity to observe the effect of muddy water.

Hand Methods.—On one of the southern projects, where the canals are operated for nearly the entire year, the most satisfactory method found is to shut the water out of the canal, put on a crew of men with shovels, and thoroughly clean the canal. Probably the crew of men with shovels is used instead of teams with scrapers because they can begin work before so much time is lost waiting for the canal to dry out. By that method they are able to free the canal from moss for a considerable length of time, although it is necessary to go through the process twice a year. It is stated that the expense of cleaning in this manner is less than a continuous operation of dragging or of fighting the moss in any other method that had been tried. However, in a canal system 100 miles or so long this would be a very expensive operation and on the Milk River Project it would usually be impossible during the operating season to obtain a sufficient crew of men to remove the moss in this manner. A thorough cleaning of the canals in the spring, however, does delay the growth of moss and probably reduces the effect of moss throughout the season.

Drying Canals Out and Killing Moss by the Sun.—Where the grade of the canal is uniform and wasteways are available so that the water can be drained out of the canal quickly this may be done and the canal be allowed to stand for a few days or perhaps a week or more in hot weather so that the sun can dry up and burn the moss. This is believed by some to be an effective procedure in killing the moss. It has not been possible to try this in the main canals on the Milk River Project, although it is believed that the growth of moss in the past year on some of the laterals was much reduced by substantially this procedure.

Submarine Saw.—One or more submarine saws have been manufactured for this purpose, with flexible steel blades designed to lie on the bottom of the canal and be operated in the manner of a crosscut saw, thus cutting the plant growth at the roots. This method has not been tried on the Milk River Project. One project reports that it was fairly successful and the canal was cleared of moss at a cost of about $35 a mile. Another project reports that it was a complete failure, that instead of cutting the moss the saw would mash it down and slide over, as the moss was not stiff enough to be cut with the saw.

Dragging with Spring-Tooth Harrow.—This has been used effectively on the Milk River and other projects, but was superseded the last season on the Milk River Project by the method of dragging by chains. One project claims that the harrow does more harm than good, the objection being that the harrows attack the bottom grade of the canal in the soft places and slide over the harder places with the result that after some time the canal bed and section become much disturbed. In places the bottom of the canal was, after con[illegible] of the harrow, found to be as much as 2½ ft. [illegible] and other portions were undisturbed; the material [illegible] from the softer places was washed down[illegible] deposited in bars, which reduced the width and [illegible] the canal. The subsequent growth of moss was then [illegible] at the deep portions of the canal, owing [illegible] to the fact that this increase in depth had occasioned [illegible] resulting low velocity. This objectionable result of [illegible] with a harrow has not been met with on the Milk River Project.

Dragging by Chains.—Two projects state that the most effective method they have found was to take a large chain, the heavier the better, and drag this upon the canals by the use of teams on each bank. This method has been used to some extent on the Milk River Project for several years. At first ordinary log chains with weights were used, but in the spring of 1919 two chains were made of 1¼-in. reinforcing steel with links about 18 in. long. These chains required no weights and proved more effective than the log chains. About 33 miles of canal were dragged with these chains, at a cost of about $9 per mile, and it was not found necessary to repeat the dragging on any portion of the canal that season. This dragging resulted in considerable improvement in the flow of the canal, but did not by any means entirely free the canal of moss growth. It was intended to use a spring-tooth harrow, for comparative purposes, on some sections of the canal adjacent to those dragged by the chains, but the field force found the use of the chains considerably more convenient and, in their opinion, so much more effective than the harrow that they put off from time to time the use of the harrow, and the season went by without the desired comparison being made. In any of these processes by dragging or sawing, the moss is merely loosened from the canal bed and banks, and it is still necessary to remove the loosened moss from the canal. On the Milk River Project this is done by men stationed at bridges below the section of the canal being cleared, who take out the moss with forks and hooks. It would be desirable to have some properly located wasteways through which the moss could be sluiced out by the use of a boom.

Dragging with Special Harrow.—One of the projects had a special kind of rake or harrow made up with knives set at an angle, and this tool was dragged in the bottom of the canal so as to cut the moss roots close to the ground. No very good description of this tool was furnished, but apparently it did not give much satisfaction and its use was abandoned for the submarine saw or dragging with chains.

Removal by Copper Sulphate.—The use of copper sulphate has been tried on some projects and has proven successful in removing a growth of algæ in a concrete-lined canal on the Yakima Project. In this case, however, there appears to have been a somewhat different species of growth from that encountered on the earth canals on the Milk River Project. Copper sulphate has been tried on earth canals on at least two projects, but in neither case with satisfactory results, and each project contemplates further experiments, using more concentrated solutions. It is stated that no objectionable effects were noted on vegetation supplied with water treated by copper sulphate and no other difficulty has developed from the presence of copper in the water. It seems, however, that a solution sufficiently concentrated to kill the moss growth on the canals of the Milk River Project would be likely to have a harmful effect upon alfalfa and other crops on which the water so treated was used. Probably this method will be given more extensive trial, and it may develop into a satisfactory process.

Placing 478-ft. Outfall Sewer from Continuous Float.—In extending the 22nd St. outfall sewer at San Pedro a distance of 478 ft. into the waters of Los Angeles Harbor, using cast iron pipe with lead joints, the rise and fall of the tide, amounting to about 8 ft., made the usual method of permitting the pipe line to sink along a skidway to the bottom of the ocean as it was laid from a boat, unsuitable. Accordingly the pipe, with its initial end tightly plugged, was suspended behind the boat from a continuous float made from old bridge floor planks until the entire length of 478 ft. was afloat. It was then sunk by removing the plug at the end and permitting it to fill with water. A coffer dam was built around the ends of the old and new pipes to connect them. The fact that the pipe showed no tendency to pull the floats down before the plug was removed proved that all joints were water tight.

New Sewage Treatment Plant of Okmulgee, Okla.

By A. H. KINBRICK
Supervising Engineer, Burns & McDonnell Engineering Co., Kansas City, Mo.

In 1917 the State Legislature of Oklahoma passed "An act to preserve the purity of the waters of the State." By the provisions of this act all plans for sewer systems and sewage disposal plants thereafter constructed must have the approval of the engineer of the State Board of Health. Okmulgee is the first city in the state to complete and put in operation a sewage treatment plant in compliance with the new law.

Imhoff Tanks and Pumping Station.

History of Okmulgee Improvements.—Okmulgee, with a population of 17,430, lies in a valley drained by Okmulgee Creek, which flows south throughout the center of the town and empties into Deep Fork of the Canadian River. As early as 1904, Okmulgee, then a town of about 2,000 inhabitants, built waterworks and sewers and constructed a septic tank some distance beyond the town limits. Both the water and sewer systems were extended from time to time until the town grew out and around the site of the septic tank, which became filled with sludge and was abandoned. An outfall sewer about 3 miles in length was then laid to carry the sewage to Deep Fork. This sewer, a 12-in. pipe, with the influx of population due to the oil industry, was soon overloaded. Sewage from the overloaded outfall was flowing in the creek within the city limits and other outfalls were discharging just outside the lower part of the town at the time the new improvements were begun. After securing the approval of the engineer of the State Board of Health to the plans and specifications [illegible] contracts were let in September 1918.

New Sewer System.—The principal feature of the sewer extensions is an intercepting sewer of 24-in. pipe and smaller sizes to collect the sewage from the overloaded old system and provide drainage for new sections, and a new outfall 24 in. in diameter. There are [illegible] of main and lateral sewers connected to the [illegible]. The grade of the outfall is twelve-hundredths per cent, but even this light grade is greater than the fall of the creek. It is therefore necessary to raise the sewage by pumping in order to carry it through the treatment plant and discharge the effluent into the natural drainage.

Sewage Treatment Plant.—The plant site consists of [illegible] acres of level ground on the bank of Okmulgee Creek about 1½ miles out of town.

The pump station is a brick superstructure over a reinforced concrete pit. The building is 19 ft. wide by 25 ft. 4 in. long. The pit is divided longitudinally by a water tight wall into a screen chamber and a dry pump pit. The sewage enters the screen chamber 7 ft. below the natural ground level where it passes through an inclined bar screen with ¾ in. openings. There are three vertical centrifugal pumps each with a capacity of 500 gal. per minute. One pump operates continuously through the night, two are in use during the day and a third is in reserve or used during unusually heavy flows. Each pump is driven by a 7½ HP motor set in the motor room above the pit. The motors are automatically started and stopped by electric switches operated by floats in the screen chamber.

The pumps lift the sewage into two Imhoff tanks where the normal sewage level is 12 ft. above the original ground surface. The two tanks are built side by side as one rectangular concrete structure 37 ft. 2 in. wide by 73 ft. 6 in. long, outside dimensions, and 26 ft. from the top of the gas vents to the bottom of the hoppers. The outside walls are vertical down to the sludge hopper and are of the buttress type. The tanks are each 17 ft. 6 in. by 72 ft., inside, and the sewage depth is 22 ft. Each tank is divided, lengthwise into two settling compartments, over a common sludge chamber, with a 6-in. slot between the overlapping sloping walls. A continuous gas vent 2 ft. wide is left between the settling compartments and 1 ft. wide between the settling compartments and the tank walls. For the convenience of the operator, walks are built on top of the division wall and also on each side of the central gas vent in each tank.

The two tanks have a combined settling capacity of 97,000 gal. and a sludge capacity of 14,000 cu. ft. The tanks are designed to treat 1,000,000 gal. per day with a detention period of two hours. The tanks are arranged for either direct or reverse flow, suitable stop boards being provided in the channels and removable plates in the inlet (or outlet) weirs. Scum walls extending 18 in. below the sewage level are set 2 ft. inside the tanks across each end.

Sprinkling Filter in Operation at Sewage Treatment Plant of Okmulgee, Okla.

Two sludge beds each 40 ft. by 80 ft., are located one on each side of the Imhoff tans, with space for future extensions. The sludge bed construction consists of low concrete walls within which is a level bed of sand [illegible] in. thick underlaid with drain tile bedded in gravel.

The effluent from the Imhoff tanks flows to a hopper-shaped dosing tank equipped with an 18-in. siphon, set for discharging when the effluent level is within 3 in. of the sewage level in the Imhoff tank and has a drawdown of 5 ft.

The sprinkling filters are designed for a flow of 750,000 gal. per day to operate at a rate of 2,700,000 gal. per acre per day. The maximum head on the nozzles at siphon discharge is 8 ft. and the minimum is 3 ft. and the effluent is sprayed evenly over every part of the filter area. The filter bed is composed of the very hard and non-impervious Joplin flint, ¾ in. to 2½ in. in sizes, and averaging 5½ ft. in depth. The underdrain system is 6-in. split tile laid open side down in parallel rows 10 in. apart on a concrete floor which slopes to the main drains. The main drains are gutters of 15-in. split tile. Vent chambers are constructed at the ends of the tile drains. Eight-inch sewer pipe risers reach from the vent chambers to above the filter walls with elbows turned to catch the breeze from any point of the compass.

Care and Operation of Plant. Unlike many towns, Okmulgee is prepared to protect and care for its investment. The grounds have been fenced with a high and strong woven wire fence. The embankments have been sodded with Bermuda grass, and an operator is employed to give the plant constant attention

Some trouble was experienced at the outset in the operation of the pumping plant due to stoppage of the screens on the suction pipes. This stoppage was found to be caused by cotton waste from garages and machine shops. An auxiliary screen was put in outside the building where the coarser refuse is disposed of. The operator now has little difficulty after cleaning both bar screens, in keeping the suction lines clear.

Foaming over in the gas vents in the Imhoff tanks occurred once, but after thoroughly breaking up the scum and reversing the flow it stopped and has given no further trouble.

The plant is producing a very clear and stable effluent and there is no offensive odor in its vicinity.

The operation of the plant is under the direction of T. P. Paxton, Commissioner of Public Works of the city of Okmulgee.

The plant was designed and construction supervised by Burns & McDonnell Engineering Co. of Kansas City, Mo.

Draining Saturated Clay for Foundation Work

In a discussion of his paper*, "Quicksand—Its Nature, Behavior, and Methods of Control," presented at the last annual convention of the New England Waterworks Association, Col. Charles R. Gow gave the following information regarding the drainage of an area of saturated clay for foundation work:

Ordinary clay, unlike sand, does not drain readily. To remove water from clay requires that it be dried out rather than drained. The best method for accomplishing this is to prevent water from coming in contact with the clay stratum and permitting the continued water to evaporate by capillary action. All plastic clays contain a high water content, and when dried they show a corresponding shrinkage in volume. The moisture in the clay is strongly held in mechanical combination and is released only through the process of surface evaporation.

Obviously, if a series of trenches are excavated in such material the area exposed to surface evaporation is greatly increased and the drying-out process will be considerably accelerated Unless, however, the trenches are very close to one another their effect as drying agencies will be limited to a very few feet laterally on each side of the trench.

If a given site is surrounded by a relatively deep trench, say, 3 to 4 ft. below the surface, having an outlet by which to dispose of accumulated moisture, and if in addition precautions are taken to exclude water from the surface of the site, there will result a drying out of the clay surface to a depth of possibly a foot or more. In case water cannot be absolutely excluded from the site, provision must at least be made for rapid surface drainage to the nearest trench, so as to lead it away before further saturation of the clay results.

---

*Engineering and Contracting, Oct. 2[illegible] 1920.

Construction and Maintenance of Tile Drains

Work on the construction of open drains on the Shoshone Project of the U. S. Reclamation Service was begun on Nov. 27, 1911, under contract. Work on the drains by Government forces was begun during the fall of 1912. By the end of the year 1919, 19.68 miles of open subsoil drains and 85.85 miles of tile drains had been constructed. The area in which drains have been constructed has a porous gravel subsoil, and the drains for the most part are constructed in this material. In some cases the top of the gravel is below the grade of the tile and the drain has been constructed in sand or sandy soil. Only one closed drain has no gravel either around the tile or in the sub-grade. About 8 miles have been constructed in material other than gravel. This material varies from a quicksand to a heavy clay. Some interesting particulars regarding the construction and maintenance features of these drains are given by Mr C. M. Jump, Superintendent of Irrigation, United States Reclamation Service, Shoshone Project, Wyoming, in the October Reclamation Record, from which the notes following are taken.

Tile Cradles.—It has been the practice on this project wherever the grade of the drain is not in gravel to use a tile cradle. This cradle is made of 2 by 4-in. lumber beveled on the edges and spaced so as to bring the support on the tile at the quarter points at an angle of 15 to the horizontal and vertical axes of the tile. Some of these cradles have been used as short as 6 ft. in length, but at present no length shorter than 12 ft. is used. In exceptional cases where the subgrade has been a quicksand, piling has been driven and the tile cradles hung in yokes on these piling. The material used for this piling has usually been broken or split lagging boards. In one case only, on Drain N, has gravel been hauled and placed around the tile. This was done for a distance of about 500 ft. In all other cases the material found in the trench was used for backfilling around the tile

Breaks and Settlements.—Breaks have usually occurred in material in which there has been no gravel. The lines have stood up very well in gravel. During the last few years there has been a slightly increasing tendency to failure of tile lines in material other than gravel on this project. From reports and observations this condition obtains on other projects wherever a considerable amount of tile drain has been constructed.

On this project breaks have occurred only in quicksand formation, and generally speaking there has been a similarity in the condition in which the tile has been found. In all cases the tile has settled and some of the tile has been broken. This settlement in one case was found to be as much as 3 ft. In all cases the tile was found filled with material, a hole showed in the backfill above the break, and water flowed from this hole.

The generally accepted practice in Reclamation Service has been to cover the upper ⅝ to ¾ in. of the circumference of the tile at the joint with tar paper. This leaves an opening at the lower portion of each joint where water can enter the tile line. Even with tile answering the specifications of the United States Reclamation Service it is not always possible to obtain as tight a joint as desired even by turning the tile in laying to secure the best possible fit. In addition, during the construction in this kind of material, water and muck often stand more than halfway up the tile, and it is not always possible to determine with absolute accuracy whether the tighest joint possible has been obtained.

In case a wide joint exists, not only water but the material from under the tile may pass into the tile and be carried away. The tile gradually settles down into the space from which the material has been removed. Such settlement causes a widening ot the joint and accelerates the process of settlement. The backfill may arch over until the tile has settled somewhat. The sudden giving away probably results in crushing some tile at the point of settlement

Failure of tile lines on the Shoshone Project has not been very extensive. The longest failure has not exceeded 150 ft., but as these breaks cost on an average of $10 per foot to repair, they result in a rather heavy item of expense

It is evident that failures of tile lines result from a removal of the material underneath the tile, allowing a settlement. This may be due to wide joints or it may take place where the best joint obtainable exists. Often water is forced up through the subgrade, which no doubt aids in forcthe material into the tile and, in addition, keeps the subgrade loosened up and in an unstable condition. Such conclusions must of necessity be drawn from circumstantial evidence but they are the result of several years' experience and embody the conclusions of project employes who have been interested in the construction and maintenance of tile drains.

The problem of preventing such failures must be taken care of in the construction of the drain, if a tile drain is to be a permanent success. There is no decided uniformity of opinion as to the best method of producing this result. There is also considerable doubt whether a tile drain can be made a permanent success in quicksand or fine clay except at a cost that would be prohibitive. The general trend of opinion in the service seems to be in the direction of discarding the use of tile drains in this kind of soil. In this matter there should be no hasty "jumping at conclusions." There may be methods that will solve the problem.

There are certain conclusions and suggestions that may be offered. (a) To construct a tile line in quicksand or fine clay with gravel or ladders set on piling of sufficient bearing strength to support the tile line may make the tile line cost prohibitive as compared with open-drain construction. To this may be added the doubtful permanency of such a construction. (b) A tile line should have no rigid points of support. It should be allowed considerable flexibility so as to adjust itself to the different conditions of support. This is not practical when drain tile is used. If it were practical to use sewer pipe in such construction, any deviation from a straight line would have a tendency to tighten the joint rather than open it, as in the case of a drain tile line. It is not known whether this has ever been tried and proven feasible. It may be possible that experiments have been tried showing the adaptability of sewer pipe in tile drain work.

Repairing Breaks.—The general practice on the Shoshone Project in repairing breaks in tile drains is to begin opening the trench below the break where the water is running out of the top of the trench. On account of the amount of water usually in the drain it is impossible to start a crib immediately over the break. The opening of the trench consists of driving solid cribbing in sections 12 to 14 ft. in length, 3 or 4 ft. wide, depending upon the size of tile. In putting down these cribs 6 by 6-in. timbers are used as wales and 2 by 8's for lagging or piling. The ground surface is taken off to a depth where the ground will stand up before the crib is started. The lagging is driven down as fast as excavation is made to keep the banks from caving. When the first crib has been put down and the tile has been uncovered the drain is opened by taking out or breaking a tile. This is necessary in order to lower the water in extending the crib over the break. In extending the crib up to the break considerable care has to be used not to fill the tile with mud below where the first crib is put down and the tile opened. In some cases, on account of the large amount of water in the drain, it has been necessary to start the crib 50 to 75 ft. below the break, depending upon conditions of the break. In some instances it has been necessary to permit the water to come to the hydraulic gradient of the tile line and wait until the water table has lowered in the fall before the broken line can be relaid. All this work requires hand labor and is very expensive, as it usually takes from 10 days to 2 weeks to open the tile line of most of the breaks on this project. There should be some other method developed that will require less time and be less expensive in repairing these breaks, as the water table is close to the surface for quite a distance up the drain from the break and is running out of the break. This condition exists in practically all of the breaks, and in one instance damage to a farmer's crop was caused for which he made a claim for $100.

As stated, there are 85 miles of tile drains on this project. It can be very readily seen that occasional breaks are to be expected. If repairs are to be continued as in the past, instead of using wooden piling or lagging, it is believed that light steel sheet piling could be used to better advantage and be less expensive in the long run, as the timber used in opening these drains is practically destroyed and is of no further value except for kindling.

Maintenance of Trap Boxes.—Another important feature in the maintenance of closed drains is the wooden trap boxes. The wooden trap boxes are beginning to deteriorate to such an extent that it will soon be necessary to repair them or replace them. Some of the trap boxes on this project have already decayed to such an extent that they have had to be repaired.

Careful consideration should be given the matter of repairing these trap boxes. The construction of the trap boxes is such that it is a very simple matter to repair them temporarily, by boarding up on the [illegible] of the 4 by 4 posts used as the frame of the structure. This, however, does not secure satisfactory construction, as the nailing must be relied upon entirely to hold the earth pressure, and when decay starts it is usually the nail holes which soften first; consequently the danger of collapse would be much greater in the repaired structure than in the original construction. The water plane does not usually recede in the fall and show the necessity of repairs until so late in the season that the ground is frozen to so great a depth that such repairs from the outside would be very costly. The life of a wooden structure alternately exposed to water and air, which is the condition obtaining in all trap boxes where repairs have been necessary, is from 8 to 10 years. From these facts it would seem that when repairs are required economy would result from the construction of a permanent structure. Aside from the necessity of reconstruction every 8 or 10 years, added security would result from the fact that there would not be the danger of the collapse of a structure where deterioration had not been observed, with the consequent filling of a tile line, the cleaning of which always requires a heavy expense. The lining of the trap box with a fairly thin concrete wall seems to be the simplest solution. This would result in supporting the old timber walls and protecting them from the deteriorating action of air and water. The trap boxes on this project are fairly uniform in dimensions, and it is believed that a collapsible metal form could be designed for this purpose, which, taken with the ease of obtaining materials, would allow an economical and efficient method for this repair, as well as obtaining a permanent structure.

Several instances have occurred on this project when it has been necessary to open a tile line and remove a bucket which had been dropped into a trap box by some careless person, while watering stock or drawing water for domestic purposes, the bucket being at once carried into the outlet tile and subsequently lodging on a projecting joint and forming a serious obstruction.

One instance is also recalled where a particular trap box was broken into several times, with no apparent cause except pure maliciousness or perhaps from a desire to use this as a fish pond. In this case no harm happened to result except the necessity of repairing the cover several times. However, in this same drain it was necessary to remove an obstruction, at great expense, caused by a small piece of timber lodging in the tile and catching sufficient floating weeds to cause a complete obstruction. These weeds could have gotten into the tile only through an open manhole. In breaking open this trap box the above condition could very easily have resulted, as in every case the timber cover was badly splintered. Every precaution possible is taken to protect the trap boxes from these thoughtless acts, but as long as they are constructed from timber only they can always be opened in some way.

It would seem that some consideration should be given the matter of a permanent type of structure at the time of the original construction. Our drainage system is of as great importance and of as permanent character to the project, or at least to those lands benefited, as our canal system. We protect our canals with the best type of construction possible; why not do the same with our drains? The cost of replacing a timber canal structure with a permanent structure is not nearly so great in proportion as that of replacing a timber drain structure, as all the work in the latter case must necessarily be carried on under adverse conditions. Yet our canals are originally supplied with permanent concrete structures, whereas in order to keep our drainage system functioning properly we must continually repair, or replace at exorbitant expense. It is believed that a cost analysis of the two types of construction would show considerable economy in permanent original construction.

It has been the practice on this project to clean trap boxes twice a year—in the spring and fall. In the spring there is very little sand in the bottom of the boxes. In the fall, after the heavy run of water, the bottoms of the boxes are practically full of sand. It is a question whether it is necessary to clean these trap boxes, as there is plenty of room for sand to deposit at the end of drains and there has been no indication of sand lodging in the tile. At the time of constructing drains it was observed that after [illegible] in operation for a year [illegible] so very little [illegible] into the drains. However, this has not prov[illegible], as the drains that were constructed eight [illegible] now carrying nearly the amount of sand they [illegible] after construction.

Tests of Centrifugally Cast Iron Pipe

Recent tests of cast iron pipe [illegible], indicate a tensile strength of more than [illegible] with the ordinary method of casting. A [illegible] method of manufacture and some tests obtained [illegible] type of pipe are contained in a paper presented by A. [illegible] McCallum, Commissioner of Works, Ottawa, Ont., [illegible] the Montreal Branch of the Engineering Institute of Canada, from which the following brief notes are taken.

The pipe, developed by de Lavaud, a French engineer, is now being manufactured and introduced in this country after exhaustive comparative tests with the ordinary standard cast iron pipe. The process of manufacture involves the application of the principle of centrifugal force to molten metal when poured into a permanent mould.

A regulated quantity of molten iron is introduced into a revolving water-cooled cylindrical mould, where, by the centrifugal force exerted, the molten metal is spread uniformly upon the inner surface of the mould. Within a few seconds the pipe is withdrawn from the mould at a red heat. The pipe is brittle after leaving the mould on account of the outer surface being chilled, but after passing through an annealing furnace it becomes tough and much stronger than ordinary cast iron pipe, as plainly shown by recent tests made by Prof. Gillespie, of Toronto University. The pipe made under these conditions has a decided contrast in structure to pipe cast in sand moulds, and has not the segregation of impurities often found in sand-cast pipe. As a consequence the pipe is a homogeneous, dense, fine-grained iron throughout, having no water or gas bubbles, and because of this density and strength it can be made much thinner.

In the tests made by Prof. Gillespie a 6-in. pipe made by this machine was compared with a 6-in. ordinary sand-molded pipe out of the same iron, with the following results:

	Centrifugally cast pipe.	Sand-cast pipe.
Thickness, in.	0.28	0.51
Tensile strength, lb. per sq. in.	37,000	16,000
Modulus of elasticity	14,500,000	8,860,000
Modulus of rupture	63,800	33,900
Quality factor	20.2	9.8

From these tests it will be seen that centrifugal pipe has very high tensile, cross-bending and resistance-to-shock values. It is apparent, therefore, that this type of pipe can be successfully made much thinner than the sand-moulded pipe. For example, a 12-ft. length of 6-in. pipe weighs 280 lb., as compared with 430 lb. for a sand-cast pipe of the same diameter.

The tests on de Lavaud centrifugally cast iron pipe show it, to all intents and purposes, impervious to corrosion, probably due to the fact that the metal being cast under pressure is of such close grain as to resist the attack of corrosive matter.

These centrifugally cast pipe have a smooth exterior and interior surface and, besides reducing hydraulic frictional losses, take a uniform surface coating. While the pipes are cast with standard bell ends they machine easily, and because of the method of manufacture the wall thickness is exactly uniform throughout and quite suitable for a threaded or straight-wall joint if desired.

Nitrate Content of Certain Waters Considered Bacteriologically Safe. The Nov. 5 Public Health Notes of the U. S. Public Health Service contains the following summary of an article by M. Starr Nichols, State Laboratory of Hygiene, University of Wisconsin, Madison, Wis., in the October Journal of Industrial and Engineering Chemistry: From nitrate-nitrogen findings of 808 Wisconsin waters these conclusions are reached: (1) An excessive quantity of nitrate nitrogen is not a normal component of safe ground waters, (2) many difficulties must be surmounted before it will become possible to set an accurate standard, but from the results here presented and from the evidence contained in the literature, a water containing 5 or more p.p.m. of nitrate nitrogen should be considered as a potentially dangerous supply until a sanitary survey can be made by a competent person, (3) the nitrate-nitrogen determination should be included in every ground-water examination.

Pollution of Public Water Supply by Spring Freshet

In the spring of 1920 the engineering division of the New York State Department of Health was called upon to investigate an epidemic of gastroenteritis, followed by an outbreak of typhoid fever in the city of Schenectady, N. Y., which occurred subsequently to the gross pollution of the public water supply of the city by the water of the Mohawk River. The results of the investigation were set forth by Mr. Theodore Horton, Chief Engineer of the New York State Department of Health, in his reports to the Department. A résumé of his reports appears in the Oct. 29 Public Health Reports of the U. S. Public Health Service, from which the following account is taken.

The matter was first brought to the attention of the Division of Sanitary Engineering on March 20, 1920, when information was received that on March 15 and a few days following, the number of cases of gastroenteric disturbances in the city had greatly increased above the number normally occurring; and that this increase had followed a noticeable turbidity in the water, which had been greatest on the night of March 13 and during March 14 and had gradually disappeared after the latter date. Although the information was not received until several days after the incidence of the largest number of cases, an engineer from the engineering division was at once sent to investigate the condition of the water supply to determine whether or not it had been, or was, such as would be likely to cause the disturbances reported. On the date of the first inspection, March 20, 1920, the water was clear and colorless, and it was therefore necessary to depend largely on what could be learned from the officials and residents of the city for information regarding its alleged unsatisfactory condition.

Samples of the water for bacterial and chemical examination were taken at several points by the department engineer and carried immediately to the laboratory for examination. At the end of one day, inoculations for the determination of the presence of B. coli indicated the probability of the presence of those organisms in all the samples, and in as small a quantity as 1/10 c. c. in one sample. It was also noted that the chlorine content of the chemical sample was about twice that of the content of the samples previously taken. These results, together with the fact that the explanation given by the attendant in charge of the water works as to the reason for the turbidity of the water, semed inadequate to the engineer making the investigation, made it appear advisable that a thorough inspection of the plant and wells should be made. This inspection was made on March 21. The results of the examination can be clearly explained only by a detailed description of the arrangement of the pumping station, the wells, and the connecting pipes.

The water supply of the city of Schenectady is obtained from three dug wells at the water works pumping station, located about 2½ miles west of the city on a flat piece of land lying between the south bank of the Mohawk River and the hills which rise abruptly from the plain about 1,000 ft. south of the river. Wash borings made a short time before the investigation indicate that the soil in the vicinity of the water works consists of clayey loam from the surface to a depth of 12 ft., the lower 2 ft. containing considerable gravel; from a depth of 12 ft. to the depth of 60 ft., a sharp coarse sand mixed with gravel containing a considerable proportion of stones several inches across; and below 60 ft., an impervious clay. Whereas the surface of the ground is practically level, the surface of the impervious stratum beneath the gravel appears to slope gently toward the wells from three directions and away from the wells or toward the river, in the fourth, or northerly direction. The wells extend through the upper 12 ft. of loam into the gravel stratum from which they receive their water. They are arranged in a line parallel to the river and about 400 ft. from it. A highway leading into Schenectady, and the Erie Canal, both parallel to the Mohawk River, lie between the wells and the river, the canal being the nearer to the stream.

Well No. 1, the oldest and most westerly of the three, is 60 ft. long, 8 ft. wide, and about 42 ft. deep. The walls, of masonry and of considerable thickness, are built of large cut stones, the lower courses apparently having been laid without mortar. The roof is formed by a well-constructed arch about 22 ft. below the surface of the ground. Near the center, a short section of the well extends to a point within a few feet of the surface of the ground, and a manhole in the roof of this section gives access to the well for inspection. The bottom of the well is the gravel encountered at that depth when the well was dug. At the time of the inspection the water in the well was clear and colorless. The walls and roof of the central section were wet, but there were apparently no material leaks. The places where the old suctions, described below, from the pump house to the river, had passed through the walls of the well were visible, but the patches which closed the openings originally occupied by the pipes were apparently tight. Open joints between the stones forming the walls of the well were clearly visible below the water line.

Wells No. 2 and No. 3 are circular in form, 42 ft. in diameter, and about 40 ft. deep. The walls are of concrete, and the roofs are apparently made of reinforced concrete supported on steel beams which span from the walls to the Phoenix columns set in the centers of the wells. As in the case of well No. 1, the bottoms are formed by the natural gravel. These two wells were, at the time of the inspection, in an entirely satisfactory condition. The three wells are connected by cast iron siphons said to be 16 in. in diameter, one between well No. 1 and well No. 2, and the other between well No. 2 and well No. 3, arranged to allow the water to flow from one well to the other. The pump suctions connect to wells No. 1 and No. 2. As near as could be learned from the available records the level of the water in the wells, with the pumps running, is usually about 210 ft. above mean tide, and that in the river is 2 ft. higher, or about 212 ft. above mean tide. At times, however, the water rises as much as 20 ft. above these levels.

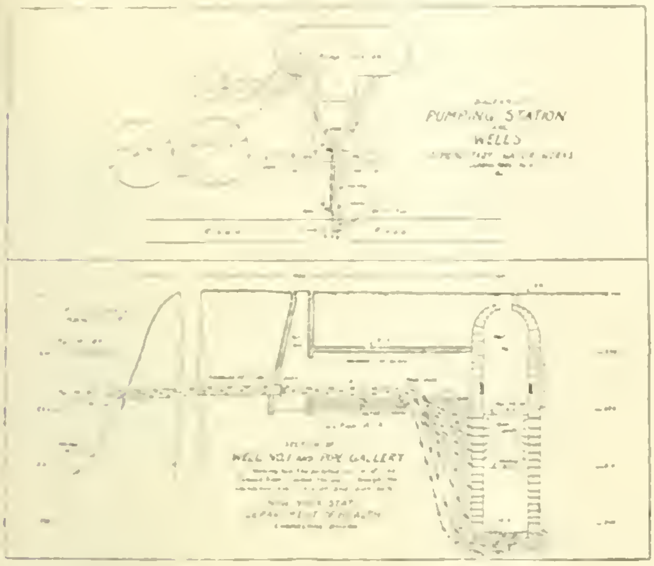


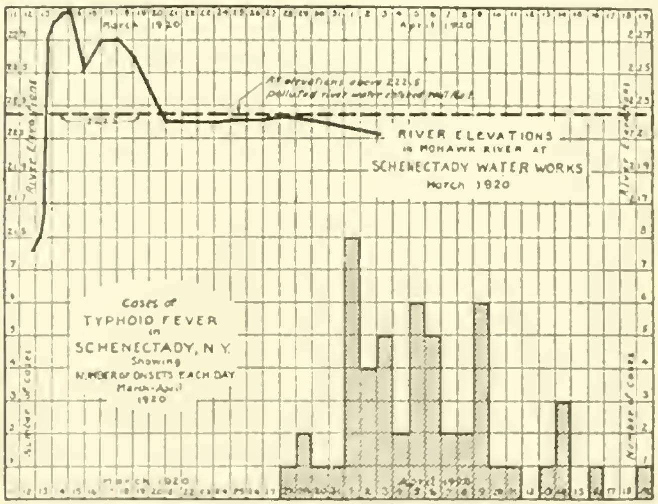
Fig. 1—Diagram of Pumping Station and Wells and Section of Well No. 1 and Pipe Gallery.

The pumping station stands about 30 ft. south of well No. 1 and at the time of the investigation housed three motor-driven vertical two-stage centrifugal pumps which lift the water from the wells and discharge it into the city mains and the 20,000,000-gal. storage reservoir. The suctions of these pumps connect to a 36-in. header, the west end of which extends into well No. 1 and the east end into well No. 2. Apparently the valves on the suction lines are generally left open so that the pumps draw from both well No. 1 and well No. 2. The water from well No. 3 can only reach the suction pipes by first passing through the siphon from that well to well No. 2.

Originally, the pump house now in use contained two large steam-driven reciprocating pumps which were connected to well No. 1 and were also provided with two 24-in. suctions extending to the Mohawk River. These two suctions passed out through the wall of the basement of the pump house about 18 ft. below the surface of the ground, extended through two converging pipe galleries to well No. 1, crossed through the raised central section of that well, mentioned above, and continued in two parallel pipe galleries to a manhole at the road about 30 ft. north of the well. From this point the pipes extended through the ground without galleries to the river. The galleries are about 6 ft. across and 8 ft. high. The walls and arched roofs are constructed of brick. The galleries are not paved, the bottom being formed by the gravel encountered in excavating them. Two manholes, one on the south side of well No. 1 and the other at the side of the road about 30 ft. north of the well, afford access to the galleries. The suction pipes had been removed from the galleries, and the holes through the walls of the well and through the wall of the basement of the pump house had been sealed with concrete and brick. The portions of the pipes from the gallery to the river still remained in place. One of these pipes, the westerly one, was sealed with concrete. The other pipe, the easterly one, was apparently open from the river to the gallery.

The existence of these galleries and the fact that they could be reached by manholes, the covers of which were made visible by the melting of the snow, became known to the engineers from the Division of Sanitary Engineering of the State Department of Health on March 24 and they were immediately inspected. The galleries between the well and the road had apparently been full of water carrying considerable suspended matter a short time previous to the inspection. The bottoms were covered with a slimy deposit of black silt to a depth of from ½ in. to 2 in., and the upper surfaces of all projections of the brick work to a height of about 8 ft. above the bottom of the gallery were likewise covered with a deposit of the same material, the quantity of deposit being less on the higher projections. The deposit of sediment was practically uniform over the bottom of the galleries, except at points in both galleries about 10 ft. from the north wall of the well. Here, in each gallery, there were several holes from 6 to 10 in. across on the top and extending from 1 ft. to 2 ft. down into the gravel in which the stones were perfectly clean, as if a swift stream had passed down through the coarse gravel at these points and carried with it all the silt and fine material. The general arrangement of the wells and pumping station, together with a section through the galleries and suction lines, giving the relative elevation of the galleries and the water in the river and wells at different times, is shown in Fig. 1.

The elevation of the bottom of the galleries is approximately 222.5 ft. above mean sea level, or about 10.5 ft. above the normal river level. An examination of the records of the river elevations kept by the lock tender at Barge Canal Lock No. 8, about a quarter of a mile west of the pumping station, revealed the fact that the river had risen from an elevation of about 211 ft. at noon on March 13 to 228 ft. at midnight on that date, over ½ of the rise, 9 ft., occurring between 2 and 3 o'clock. The river reached its maximum elevation of about 230 ft. at 1 p. m. on March 14; and after that time the elevation gradually fell, reaching 224 ft. on the 20th and 222 ft. on the 21st of the month. The elevation of the water in the wells, figured from the record of the vacuum on the pump suctions, rose more slowly than that of the water in the river, the maximum rate of the rise being about 1 ft. per hour. The river elevation was, therefore, for a considerable time, several feet above the elevation of the water in the wells. On the afternoon of the 13th this difference varied from 6 ft. at noon to about 14½ ft. at 3 p. m., dropping again to 7 ft. at midnight. During the entire day of the 14th the elevation of the river was a little over 6 ft. above the elevation of the water in the wells, and from that



N. York State Department of Health—Engineering Division

Fig. 2—River Elevations and Cases of Typhoid Fever.

...on gradually decreased, the difference on the 20th being only about 9 in.

Compared with the elevation of the bottom of the pipe gallery, these figures indicate that the river surface was above the floor of the gallery from 2 o'clock on the afternoon of March 13 until March 20, and that during the afternoon of the 13th and during the 14th the river surface was between [illegible] and 8 ft. above the bottom of the gallery while the water in the well remained below the bottom of the gallery.

Apparently, therefore, from the 13th to the 20th of March there was nothing to prevent the polluted water of the Mohawk River from flowing from the river to the galleries through the open 24-in. suction line, then along the galleries and, as indicated above, down through the wash holes a few feet from well No. 1, and through a few feet of coarse gravel into the well either by way of the joints in the stonework or up through the open bottom. The largest rate of flow into the well by this means would, of course, have occurred on the 13th and 14th of the month, when the difference in elevation between the surface of the river and the surface of the water in the well was greatest, and would have gradually decreased as the difference in elevation became less. This is in general accordance with the evidence as to the turbidity in the city water, which is said to have been the greatest on the night of the 13th and during the 14th, gradually becoming less during the week and finally disappearing about the 19th or 20th.

The open suction line and the probability of its being the cause of gross pollution of the water was at once pointed out to the superintendent of water of the city, and he immediately had the open pipe sealed. A report on the conditions was sent to the city authorities shortly afterwards, in which it was recommended that the possibility of further pollution of the water from this source be prevented by the removal of part of the suctions between the well and the river. This recommendation was also carried out by the city authorities. The removal of the possibility of further pollution did not, of course, prevent the damage done by the gross pollution and infection of the water between March 13 and March 19. An epidemic of gastroenteritis disturbances occurred on March 15 and lasted for several days. On March 28, 15 days after the first pollution of the water, or 10 days after the day on which the inflow of polluted water into the river ceased, one case of typhoid was reported. Others followed. On April 1 the onsets of eight cases occurred, and for the next week the number of onsets ranged from two to six, the number gradually decreasing. The last case was reported as occurring on the 19th. In all there were 53 cases, 3 of which terminated fatally. The majority of the cases occurred about two weeks after the pollution of the well by the contaminated water of the river.

Strength of Welded Pipe Joints

The strength of pipe joints welded by means of the oxyacetylene process is shown by a series of interesting tests conducted at the plant of the Linde Air Products Co. during the period of the Buffalo gas show. An account of these tests is given in a recent issue of Power Plant Engineering as follows:

The first test piece consisted of two short pieces of 3-in. standard pipe welded together end to end. The outer ends were capped with standard cast iron caps. When cold water pressure was applied, the top of one of the caps blew off without injury to pipe or weld. The same pipe was then fitted with extra heavy cast-iron caps, and, again, one was blown off, this time at a pressure of 6,200 lb. per square inch.

For the third test extra strong steel caps were used, with the result that the pipe split open lengthwise from one of the caps up to the welded joint where it stopped.

Two further tests were made with 4-in. pipe welded together in the same manner as the 3-in. pipe, in the first three tests. Extra heavy cast iron caps were first used with the result that one cap failed at [illegible] lb. per square inch, or about [illegible] tons total end pressure, without effect on the weld. Two shorter lengths of 4-in. pipe were then welded together and capped with extra heavy steel caps. This time the pipe failed at the threads close to the cap, under a pressure of 4,200 lb. per square inch. In all of the tests described, the welds held perfectly.

Effect of Fittings on Flow of Fluids Through Pipe Lines

The problem of making proper allowance for the frictional resistance of pipe fittings is frequently encountered in piping layouts. Dean E. Foster, Consulting Engineer, Tulsa, Okla., in a paper prepared for presentation at the annual meeting of the American Society of Mechanical Engineers, has elaborated on formulas previous developed in a treatise by Konrad Meier, and has worked up a set of tables which are quite useful in this class of work. The following is an abstract of the paper:

For the flow of water through pipe lines Mr. Meier uses the formula.

$$H_f = \frac{0.0257}{2g} \times v^{1.86} \times \frac{L}{d^{1.25}}$$

where H_f = loss of pressure in ft.
v = velocity in ft. per sec.
d = diameter in in.
L = length in ft.

This equation agrees within 5 per cent with Gardner S. Williams' formula, which is so widely used in this country.

For resistance offered to flow by fittings, Mr. Meier gives the following:

$$H_r = 1.38r \times \frac{v^{1.86}}{2g}$$

where H_r = ft. of pressure loss per fitting
r = a factor of resistance whose value depends upon

TABLE I—EQUIVALENT LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING NON-VISCOUS LIQUIDS[1].

Formula used: $L_e = 53.75rd^{1.25}$.

Nominal pipe size, in	Actual inside diameter, in.	Gate valve	Long-sweep elbow or on run of standard tee.	Medium-sweep elbow or on run of tee reduced in size ¼.	Standard elbow or on run of tee reduced in size ½.	Angle valve.	Close return bend	Tee through side outlet.	Globe valve
Factor of resistance.....		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
½	0.662	0.335	0.442	0.56	0.89	1.20	1.34	1.79	2.68
¾	0.824	0.475	0.627	0.79	1.27	1.71	1.90	2.52	3.80
1	1.049	0.640	0.844	1.07	1.72	2.30	2.56	3.40	5.12
1¼	1.38	0.902	1.19	1.51	2.42	3.24	3.61	4.80	7.22
1½	1.61	1.09	1.43	1.83	2.92	3.92	4.36	5.79	8.72
2	2.06	1.49	1.96	2.50	3.99	5.36	5.96	7.92	11.92
2½	2.46	1.86	2.46	3.13	5.00	6.72	7.47	9.93	14.94
3	3.06	2.46	3.25	4.11	6.66	8.87	9.86	13.11	19.72
3½	3.54	2.92	3.80	4.91	7.84	10.53	11.70	15.56	23.40
4	4.026	3.44	4.53	5.77	9.22	12.37	13.70	18.28	27.50
4½	4.506	3.95	5.20	6.63	10.60	14.22	15.80	21.01	31.60
5	5.047	4.57	6.00	7.68	12.26	16.47	18.30	24.33	36.60
6	6.065	5.72	7.55	9.61	15.30	20.61	22.90	30.45	45.80
7	7.024	6.90	9.10	11.59	18.50	24.84	27.00	36.70	55.20
8	7.981	8.10	10.69	13.60	21.70	29.16	32.40	43.09	64.80
10	10.026	10.70	14.10	17.97	28.70	38.52	42.80	56.92	85.60
12	12.090	12.50	17.80	22.68	36.20	48.60	54.00	71.82	108.00

TABLE II—LENGTHS OF STANDARD PIPE TO ALLOW FOR VARIOUS SCREW FITTINGS IN CONDUITS CARRYING STEAM, AIR OR GAS.

Formula used: $L_e = 43.7rd^{1.2}$.

Nominal pipe size, in	Actual inside diameter, in.	Gate valve.	Long-sweep elbow or on run of standard tee.	Medium-sweep elbow or on run of tee reduced in size ¼.	Standard elbow or on run of tee reduced in size ½.	Angle valve.	Close return bend.	Tee through side outlet.	Globe valve.
Factor of resistance		0.25	0.33	0.42	0.67	0.90	1.00	1.33	2.00
½	0.622	0.031	0.41	0.52	0.84	1.12	1.25	1.66	2.50
¾	0.824	0.041	0.57	0.73	1.17	1.57	1.75	2.33	3.50
1	1.049	0.057	0.77	0.98	1.57	2.11	2.34	3.11	4.68
1¼	1.380	0.082	1.07	1.37	2.19	2.94	3.27	4.35	6.54
1½	1.610	0.098	1.29	1.64	2.63	3.52	3.92	5.21	7.84
2	2.067	1.32	1.74	2.23	3.55	4.77	5.30	7.05	10.60
2½	2.469	1.64	2.16	2.75	4.39	5.91	6.56	8.71	13.12
3	3.068	2.13	2.81	3.59	5.72	7.69	8.51	11.40	17.08
3½	3.548	2.53	3.34	4.26	6.80	9.10	10.13	13.50	20.26
4	4.026	2.96	3.90	4.97	7.94	10.65	11.84	15.75	23.68
4½	4.506	3.27	4.45	5.66	9.05	12.14	13.50	17.95	27.00
5	5.047	3.88	5.11	6.42	10.40	13.95	15.51	20.60	31.02
6	6.068	4.81	6.35	8.09	12.90	17.35	19.27	25.60	38.54
7	7.023	5.75	7.59	9.66	15.40	20.70	23.02	30.60	46.08
8	7.981	6.70	8.85	11.20	17.90	24.10	26.80	35.60	53.60
10	10.02	8.75	11.54	14.70	23.40	31.50	35.00	46.60	70.00
12	12.09	10.90	14.40	18.35	29.30	39.30	43.70	58.10	87.40

the shape of the fitting

v = velocity of the fluid in ft. per sec

By combining these two equations we obtain

$$L = 53.75r \times d^{1}$$

where L represents the number of feet of pipe equivalent in resistance to a fitting the other factors as before. Table I has been made up from this equation and may be used for water, crude or refined petroleum oils of 32° B. gravity or lighter, or other non-viscous liquids.

For the flow of high-pressure steam through pipes Mr Meier uses the equation

$$P_f = \frac{W}{144} \times 0.0257 \times \frac{v^2}{2g} \times \frac{L}{d}$$

where P_f = pressure in lb. per sq. in. to overcome frictional loss.

For resistance offered to flow by fittings he gives

$$P = \frac{W}{144} \times 1.12r \times \frac{v^2}{2g}$$

By combining these two formulas we obtain

$$L_s = 43.7rd^{1}$$

There is no reason to assume that the flow of gas or air through fittings should occasion losses differing from those caused by the flow of steam. Hence the writer assumes that the equivalents of Table II may be used for all three fluids.

Use of Table I is illustrated by the solution of the following problem which assumes that 4-in. line is to handle 26.2 cu. ft. of water per minute through a horizontal run of 50 ft., at which point the line rises at right angles 35 ft., thence runs horizontally 120 ft. to a tee heading a manifold consisting of five pieces of 4-in. pipe 12 ft. long connected by 4-in. tees, each delivering one-sixth of the total quantity of water. A centrifugal pump is to be selected and properly speeded to handle this quantity of water. The pump is to be located 10 ft. above the water surface.

Since the frictional resistance of pipe varies approximately as the square of the quantity of water passing through it, it will be convenient to combine the last 12 ft. of horizontal run with the first tee. This will give us 6 sections of 4-in. pipe each 12 ft. long and having a connecting tee. From Table I for liquids we find a 4-in. tee equivalent to be 4.53 ft. of 4-in. pipe making each section the equivalent of 16.53 ft. in length. From Cox's tables for flow of water through pipe lines we find a loss of 2.563 ft. per 100 ft. for a 4-in. line handling 26.2 cu. ft. of water per minute. The loss for the first section, which carries all the water will be 16.53 × 2.563/100 or 0.424 ft. For the second section, which carries 5/6 of the total, tho loss will be as the square of the quantity carried, or 5/6 × 5/6 × 0.424 = 0.295 ft.

For the entire manifold the losses will be as follows:

	Feet.
Section 1 (6/6)² × 0.424	0.424
Section 2 (5/6)² × 0.424	0.295
Section 3 (4/6)² × 0.424	0.198
Section 4 (3/6)² × 0.424	0.131
Section 5 (2/6)² × 0.424	0.047
Section 6 (1/6)² × 0.424	0.012
Total loss for manifold	1.107

For the remainder of the line we have:

	Feet.
Suction line	10
100 diameters for pump	100
First horizontal run	50
Riser	35
Second horizontal run	108
Three 4-in. standard elbows, each 9.22	27.66
Total equivalent length of pipe to Section 1 of manifold	330.66

and from the foregoing:

	Feet
Loss on 330.66 ft., 2.563/100 per ft.	8.47
Loss through manifold	1.11
Total loss	9.58

The total pumping head then will be as follows:

	Feet
Suction head	10.00
Elevation	35.00
Friction head	9.58
Total head	54.58

Road Construction for Heavy Truck Traffic. The Engineers' Club of Philadelphia will hold a meeting in auditorium of the club, 1317 Spruce St., Philadelphia, Pa., at 8:15 p. m., Dec. 21, to discuss the subject of "Road Construction for Heavy Truck Traffic." A number of prominent authorities, including State Highway Commissioners, will be present; papers will be read and a general discussion had on the subject, in order to bring out information of practical value.

The Land Drainage Situation in Illinois

The State Legislature of Illinois last year authorized the State Geological Survey Division to make a study of the status of drainage within the state, with the object of determining whether or not the state should give any assistance in the reclamation of its overflowed lands. Some results of this investigation are given by Mr. F. W. DeWolf, Chief State Geological Survey, and Mr. G. W. Pickels, in a paper presented last month at the 9th annual meeting of the National Drainage Congress. The notes following are abstracted from the paper.

In carrying out the investigation special attention has been given to determine the location and magnitude of (1) the areas already reclaimed through the organization of drainage districts, (2) the areas being organized into districts at the present time, and (3) the overflowed areas and wet uplands for which no provision has been made. Due to the criticism of the state drainage laws, particular information has been sought as to the difficulties which had been encountered in forming districts under it; also as to any other obstacles which have hindered the construction of drainage projects.

The field work was started in July, 1919, and completed in September, 1920. No instrumental surveys were made. The desired information was secured from county and township records and from correspondence and personal conferences with drainage commissioners, engineers, drainage attorneys, land owners, county farm advisers and others who were familiar with the facts. At present the information which has been collected is being prepared as a report which will be ready for distribution about Feb. 1, 1921.

The study reveals that approximately 1,035 districts have been organized under the township drainage laws of the state. These vary in size from a few hundred acres to over 100,000 acres each. The total areas have not as yet been computed.

The total acreage of the overflowed lands is not available at present, but the estimate of 1,000,000 acres is conservative.

There is considerable activity being manifested at present and about 150 districts are in various stages of organization. Two of these contain 80,000 acres each, and are outlet districts having for their object the straightening of river channels to provide better outlets for existing units. Some such projects are to cost $20 per acre.

About 75 per cent of the overflowed lands along the Mississippi and Illinois Rivers has been protected by levees and drained by interior ditches and the water removed by pumping. Some of this work has cost $15 per acre. However, along the smaller interior streams, very few levees have been constructed and those which have been are for the most part inadequate; and, with one exception, none of these districts operates pumping plants. Thus far the land which has been reclaimed is the higher land which was the most readily drained. Of the districts which have included land up to the banks of the streams, only a few have been completely successful, and in most cases the land is little better off than before the districts were formed.

The big drainage problem at present is the providing of better outlets for existing districts and those which will undoubtedly be formed as soon as satisfactory outlets are provided. This can be accomplished only by straightening and cleaning the crooked and drift-choked channels. Since 1917 it has been legally possible to carry out projects of this kind and at present several such are being organized. Where the stream does not extend through more than one or two counties and its fall is sufficient to promise relief from overflow without the construction of levees, the land owners can handle the situation. A number of such enterprises are now on foot. But it is extremely difficult to organize the larger valleys, owing to the large number of land owners and the large amount of preliminary work and expense involved in the preparation of a petition. In a number of localities the sentiment is in favor of the state assisting to a greatrer or less extent. Some think the state should bear all the expense of these undertakings; but the majority of the land owners are willing to pay their part of the cost though unwilling to give the necessary time to promote such projects. Others feel that the state should assist in the same way that the Federal Government did in the irrigation of the arid lands of the West by taking over the lands, reclaiming them, and then disposing of them to private owners on a basis [illegible] reimburse the state.

As illustrating the results of the [illegible] the state map has been colored to show the present conditions of organized effort in several typical [illegible]. The colored areas include 278 organized [illegible] including 1,000,000 acres, 14 districts in process of [illegible] which include 375,000 acres, and 60 un[illegible] remaining 462,000 acres of overflowed land which are still waiting for concerted action.

It is hoped that the constitutional convention which is in session this year will recognize the public character of the reclamation problem and will adopt provisions favorable for organizing large districts under co-operative effort of state, county, municipalities, and land owners. At any rate, the present statutes seem to need revision and so the present inquiry enlisted the service of two drainage attorneys and has included a thorough study of the Illinois laws and those of other states. Questionnaires, asking for opinions on special phases of the law, were sent to all the drainage attorneys in the state, and a tentative draft of a revised law is now being prepared, based largely upon the information thus obtained. Probably conferences will be held at a number of points in the state to discuss and perfect some measure which can be presented with confidence to the legislature which convenes in January.

As the Lawyer Sees the Engineer

At a recent meeting of the Boston Chapter of the American Association of Engineers, Mr. Thornton F. Alexander, attorney for the Boston & Maine R. R. and past major in the Construction Division of the United States Army during the war, spoke on the topic, "As the Lawyer Sees the Engineer." He likened the engineering profession to the profession of law in that both the lawyer and the engineer, in order to properly serve their clients, the public, must study the problems presented to them analytically and synthetically construct the framework of data upon which they form their judgments. Their difference, however, lies in the fact that whereas the lawyer deals with laws which are variable and unsettled, being influenced by public opinions, desires and customs, the laws of engineering being founded in nature itself, are steady and unshaken—the same today as they were 3,000 years ago and as they will be 3,000 years hence. Each must be careful to employ thoroughness of research and to use soundness of judgment.

He then went on to say that engineers like many other practical men, neglect the fact of the existence of law and do not see to it that their projects, whatever they may be, line up with the principles of law. As an example of this fact he mentioned the many troubles that have arisen through the neglect of engineers to investigate what the laws on the statute books are regarding navigable waters. Upon receiving a contract for a bridge over a stream or river, or a wharf extending into the waterway the average engineer proceeds immediately to work out the design of the structure without investigating to see what kinds of bridges or wharves are restricted by law, what the laws have to say about such construction. Even though the stream may be small, yet it may, on the statute books be called "navigable." He must see that he obtains a license by the state or the government or his plans approved by the government or he may be forced to pull out his structure after it is already built. This has happened many times.

Then regarding contracts, Mr. Alexander mentioned the fact that care must be taken in the drawing up of contracts; they must be clear and definite; there must be no loopholes through which some unscrupulous sub-contractor or worker can crawl or make use of unworthy materials. Great care must also be taken to see that the construction agreement is clear and definite, that all plans and specifications are correct—defective plans and specifications are a menace to the owner, for if trouble results from the use of these he is responsible. The engineer must also see that the object of the project is not against the law, as work which is done on unlawful projects does not need to be paid for.

Touching upon the part that engineers take on the witness stands of the courts, he stated that they must be sure that they are fully prepared through training and experience and careful study to make proper statements and decisions, that they must be sure to present their case to the court openly and fairly, but not too over-zealously; that they must speak without conceit.

The Economic Use of Water*

By C. M. SAVILLE,

[illegible] and Chief Engineer, Board of Water Commissioners, Hartford, Conn.

In a broad and general sense the question of, "What is the legitimate use of water?" opens up such a large opportunity for discussion that it seems impracticable at this time to attempt to do more than consider a few special problems.

For example, is it a legitimate purpose to use pure water brought at great expense from long distances for the extinguishment of fires, or is it in keeping with modern thought in conservation to draw from the city supply large quantities of filtered water for use in mechanic arts when other water will suffice? Related to this phase is the moot question as to the propriety and desirability of selling water to a large consumer at or below cost in order to obtain his trade. These, perhaps, may be called questions of ethics, but every gallon of water so used hastens the time when an additional supply is needed, and with every increase in supply progressively greater difficulty in obtaining proper water for domestic use must be encountered. This results from the growing scarcity of good water supply grounds in the vicinity of our cities and the mounting cost of construction works for extension and for water purification.

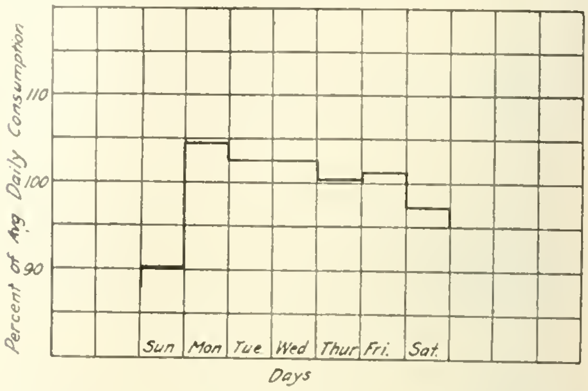


Fig. 1—Comparison of Actual and Average Daily Consumption.

Among the many phases of this problem is the quantity of water to be judged as legitimately used or useful for that purpose which must in the end take priority over all others, namely, the use of water for human needs and for potable purposes.

A statement of this portion of the problem resolves itself most naturally into a presentation of statistics and results of inquiry. This in turn can only be discussed in a very general way without study of data, some of which it is my purpose to present to you with the hope that deductions may be drawn or ideas suggested which may be of value for the improvement of waterworks operation.

The primary object is to serve the people with a necessary commodity in as economical and efficient a manner as possible.

In studying the data collected and the conditions under which they were obtained, it is evident that rate of use is nearly as important as the actual consumption of water; that these two are inter-related, and that present-day living conditions and requirements must be considered.

There are causes for increase in consumption other than waste, and a bare comparison of per capita consumption figures may be most misleading.

The basis on which the number of consumers is estimated, the character of the houses, the requirements of the inhabitants in installation of modern plumbing facilities, the extension of sewers and other growing demands for modern personal conveniences has much to do with the legitimate use of water. The pressure under which water is supplied, the increase in pressure in the same system due to additions and reconstruction, and the requirements for mechanic arts and commercial purposes are of no small effect. All of them must be given weight when comparisons are made of unit consumption records.

The Increasing Use of Water.—As recently as 15 years ago many tenement houses in our largest cities were unsupplied with plumbing fixtures other than a cold water faucet and a community water-flushed toilet. Today few apartment blocks of even low rent value of our cities are now fully equipped with individual conveniences which promote a comparatively lavish use of water, and public health authorities are actually pushing these requirements.

---

*Abstract of a paper presented at the Montreal Convention of the American Water Works Association.

These tendencies of the times must be recognized by the waterworks man and provision made for future water service in all communities to meet the present demands of city dwellers.

This probably means a greatly increased per capita domestic demand during a transition period of a score of years perhaps in suburban and country localities and thereafter in all localities a more slowly advancing rate of increase which would tend to approach a uniform rate of consumption.

For this transition period it seems probable that the rate of increase per capita per year may be at least from 2 to 3 gal. more than the present normal and thereafter provision should be provided for an annual increase of from ½ to ¾ gal. per day per consumer.

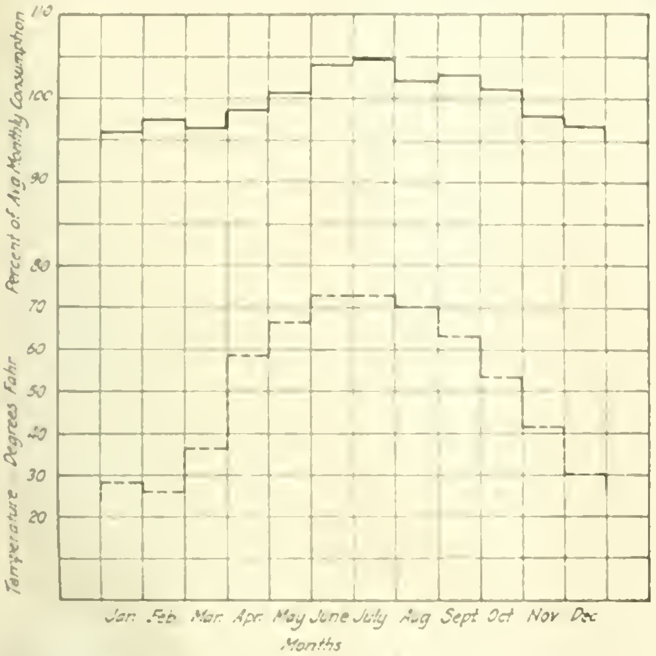


Fig. 2—Comparison of Actual and Average Monthly Consumption.

with this legitimate increase in the use of water is, of course, the elimination of needless and useless waste. Methods for accomplishing this result, admirable in itself, however, should be carefully considered with reference to cost and the results practical of accomplishment in individual cases. While it is always commendable to stop waste of any kind, the immediate financial results of saving the last drop of water are not so apparent in connection with an unfiltered gravity supply from an abundant source as they are when all the water must be pumped or filtered, or both.

Water Consumption in Hartford.—The city of Hartford is practically fully metered, the only unmetered supplies being fire protection services unused except in emergencies and some use of water for street watering, sewer flushing, water main flushing and by fire hydrants. In 1915 a rather intensive study was made of water use conditions with the following results:

	Mil. Gals. Per Day	Gallons Per Capita.	Per Cent of Total.
Domestic	4.74	33	50.4
Manufacturing	2.73	19	29.0
Public	0.43	3	4.6
Unaccounted for	1.50	10.5	16.0
Totals	9.40	65.5	100.0

In 1919 the average daily draft has increased to 11.88 million gals per day, and while as yet no close study has been made, it seems likely that although the unaccounted-for water may have somewhat increased, it is still less than 15 gal. per capita per day or perhaps 20 per cent of the total consumption of the city.

Manufacturing and Industrial Use.—The amount of water used from the public supply for manufacturing and industrial purposes in Hartford is quite inconsiderable considering the numerous and extensive plants which are located here. This condition is accounted for by the fact that much of the water used for these purposes is furnished by private supply from driven wells or nearby streams. This condition, too, somewhat accounts for Hartford's comparatively low consumption and undoubtedly, if as much water were drawn here from the public supply as in some other cities with similar industrial activity, the rate of per capita consumption would be considerably increased from perfectly legitimate uses.

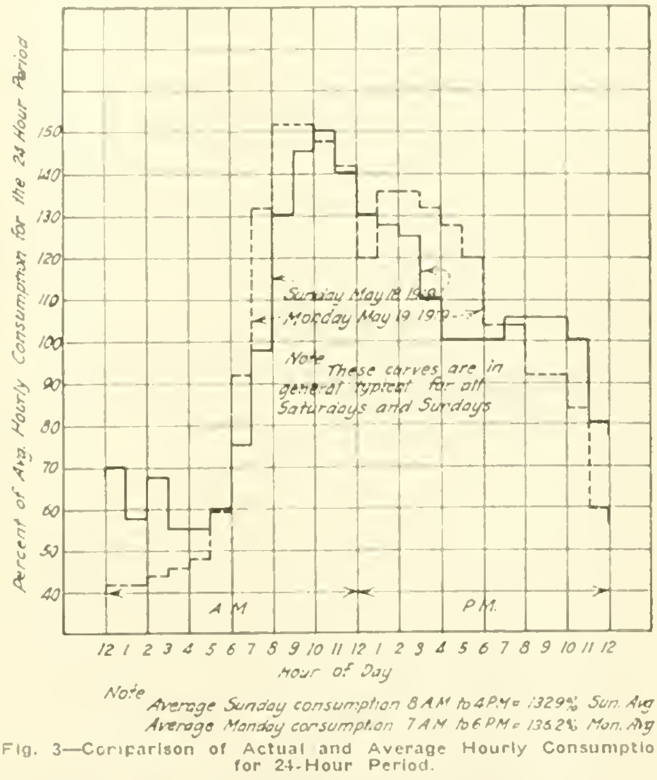
Public Use.—A study of the principal uses of water for public purposes indicates that the amount of water so used probably does not exceed 450,000 or 500,000 gal. per day, allocated about as given below:

Service.	Mil. Gals. Per Year	Gallons Per Capita Per Day
Fire—Station use	[illegible]	[illegible]
Extinguishing fires	[illegible]	[illegible]
Parks	[illegible]	[illegible]
Police station use	[illegible]	[illegible]
Streets—Drinking fountains	[illegible]	0.10
Horse fountains	[illegible]	0.042
Sprinkling and flushing	[illegible]	[illegible]
Miscellaneous	0.4	[illegible]
Schools	[illegible]	[illegible]
Miscellaneous buildings	20.8	0.397
Estimated unaccounted for	[illegible]	1.057
Total	[illegible]	[illegible]

Fire Department Use.—The total use of water for extinguishing fires is comparatively small in the course of a year. The rate of demand, however, for short periods is often very great, so great, in fact, that in cities of 100,000 to 150,000 population a reasonable requirement for fire protection service often equals or exceeds the maximum hourly rate of draft of an ordinary day. The total amount of water used by the fire department of Hartford in the past year was about 7,000,000 gal., or a little over a pint per capita per day, of which about one-half was used in the maintenance of 16 stations, including washing of hose and apparatus. The remainder was used in the extinguishing of fires.

The following data from fire department records of 1914 is an indication of service conditions in this city:

Total actual fire alarms	628
Number fire calls at which water was used	105



Note
Average Sunday consumption 8 A.M. to 4 P.M. = 132.9% Sun. Avg.
Average Monday consumption 7 A.M. to 6 P.M. = 136.2% Mon. Avg.

Fig. 3—Comparison of Actual and Average Hourly Consumption for 24-Hour Period.

Number of times pump service available	63
Number of hose streams in use, average	2
Length of hose line, average, feet	380
Usual size nozzle, inches in diameter	1 to 1¼
Average hydrant pressure in service	60 to 80 lb.
Average pump pressure	100 to 200 lb.
Total amount of water used	3,000,000 gal.
Value of property included in the fires	$7,973,109
Insurance thereon	3,348,310
Insurance loss	14,590

The following table shows the duration of hose service at fires in 1914:

Number of Fires.	Duration of Service.
50	15 minutes.
25	15 minutes to 30 minutes
15	30 minutes to 1 hour
11	1 hour to 2½ hours

[illegible]
4 hours [illegible]

Of the 107 alarms at which water was used, three or more streams were in service at only 16. There were seven calls at which five or more streams were used, four at which nine streams were used and one at which [illegible] streams were in service.

[Mr. Saville's paper contains a table giving an analysis of the seven fire calls in the year 1914 at which five or more streams were in service.

These seven fires used a total of 2,18[illegible],190 gal. or about two-thirds of the entire amount used to put out fires, leaving 1,117,810 gal. to be used by the other 98 calls, or an average of about 11,400 gal. per fire call.

On Dec. 18 five 2.5-in. streams averaged 270 gal. each per minute for 55 minutes, no stream exceeding 300 gal. per minute. On Jan. 20 nine 2.5-in. streams averaged 260 gal. per minute for 4 hours 20 minutes, delivering a total of 613,370 gal.]

On Jan. 29-30, 1917, occurred the most serious fire test that has yet visited Hartford. On that date a large department store was destroyed with loss aggregating $613,000. Twenty pieces of apparatus were in action, including 13 pumping engines and watertower. In all the equivalent of 18 single streams were employed simultaneously at this fire. It is estimated that about 3½ million gallons of water were used at this time, and for four consecutive hours the draft was at a rate of 10,000 gal. per minute. This rate, it is interesting to note, is exactly that recommended for Hartford's congested district by the engineers of the National Board of Fire Underwriters in 1916.

Unaccounted for Water.—This amount of water is the difference between the amount registered on the master meter on the supply pipe line and the sum of consumer meters plus a comparativly small amount to known unmetered uses. The quantity thus drawn is due to leakage from underground main pipes and services, under registration of meters, probably some illegitimate use and some unmetered public use as for flushing water mains, factory tests of private fire protection systems, etc.

The total amount unaccounted for is estimated at less than 15 gal. per capita per day. In his report on the Boston Metropolitan Water District, the late Mr. Dexter Brackett, one of the foremost water distribution engineers of the country, stated this amount to be "a minimum quantity and could only be maintained by a thorough meter system and constant inspection." Mr. John R. Freeman, in his report on New York's Water Supply (1900), puts 10 gal. per inhabitant per day as "the irreducible waste with every service pipe metered and most rigid inspection."

Domestic Consumption.—What may be the proper and legitimate amount of water for domestic purposes is a complex problem that includes many factors which are not capable of exact solution because of their dependence on human habits and social requirements as well as necessities of life.

Table I gives data concerning conditions in several municipalities where accurate and carefully obtained information has been available.

As showing the tendency for increase in the per capita consumption data from the Boston (Mass.) Metropolitan District are available, and comparison of 5-year periods is given. These municipalities are similar in their characteristics and are practically residential communities; that is to say, they have no large industries which dominate the locality and a very large proportion of the population of all of them have their employment in Boston. These cities have all been fully metered for the past 10 years or more. During the past 5 years the following consumptions have been observed.

In their report (1915) on additional water supply for the city of Providence, R. I., Messrs. P. P. Stearns and others state (page 6): "The city of Providence has for many years sold water on a meter basis, and the consumption per capita is low. It is, however, higher at the present time than it was 10 or 12 years ago, the increase in per capita consumption having been on an average about ¾ gal. per capita per day."

TABLE I. WATER CONSUMPTION IN 5 CITIES

Municipality	Year 1913 Population	Year 1918 Population	Gals Per Capita Consumption. 1913	Gals Per Capita Consumption. 1918.	Increase in per capita Consumption. Per Year
Malden	48,950	52,150	46	62	3.2
Medford	26,[illegible]	[illegible]	48	62	2.8
Melrose	16,920	17,870	55	66	2.2
Milton	[illegible],620	[illegible],250	40	47	1.4
Swampscott	6,770	7,960	65	76	2.20
Means and Totals	107,790	1[illegible],820	51.8	62.[illegible]	2.18

Increase in population [illegible]
Increase in consumption [illegible]

In the report on the "Enlargement and Improvement of the Baltimore (Md.) Water Supply," Messrs. J. R. Freeman and F. P. Stearns (page 24) state, "It must be recognized . . . that there is a strong tendency manifest in nearly all the large American cities for the per capita supply of water to increase from year to year."

In his report on "Water Supply for the City of Cambridge, Mass." (1903), (page 18), Mr. Freeman C. Coffin said: "The rate of increase in the consumption of water of 5.475 per cent per year or about 30 per cent in five years, is higher than that of the increase in population which is 13 per cent in five years. This is explained by the increase in the rates of the per capita consumption or the daily consumption of water by each person; that is, the consumption of water not only increases on account of the increase in population but as the population increases the use of water per person increases," and on (page 13): "While the increase in consumption was from 1,626,000 to 8,928,914 gal. daily in 30 years or about 5.5 per cent per year, the increase in population is from 45,166 in 1872 to 94,152 in 1903 or about 2½ per cent per year or about ½ the rate of the increase in the population."

Rates Charged for Water.—It has been said that there is no basis for establishing a rational system of flat charges, and that such a scale of rates is at best a makeshift, with one man's guess as good as another's. This is, without doubt, an absolutely correct statement, yet a close analysis of the use to which water is put in a small residential community enables some comparisons to be made of the use of water for domestic purposes and of the cost of water to consumers by metered and flat rates. One must, however, bear in mind the fact that such a comparison is not an entirely true index of the amount of water which would be drawn by these same houses were they paying for service under the flat rate system uncontrolled by the meter in the cellar.

In the section under consideration there were 1,878 persons served by 379 connections with the water main system, all of which are metered. The average family was, therefore, 4.9 people, using an average of 25.2 gal. per capita. The district owns and maintains its pipe system but purchases water from the Hartford Water Department who supply maintain and read house meters and make collections. By meter rates at 12 ct. per 100 cu. ft. and a minimum charge of $5 per connection, the district paid $3,414 for water last year at an average rate of about $9 per connection.

Eight years ago the district installed its system of about 5 miles of pipe, mostly of 4-in., 6-in. and 8-in. sizes, at a cost of about $26,000. An average of fixture rate charges paid to 27 private water companies in Connecticut similar in character to the district under consideration, gives the following annual rate schedule in force prior to 1918:

Single family (or faucet)	$ 6.00
Water closet, one	4.00
Bath tub, one	4.00
Set tubs, two tubs	1.50
Silt cock or use of hose	5.00
Total per year	$20.50
Extra:	
Additional closet	$ 1.50
Additional bath tub	2.00
Horse or cow	1.00

By metered rates in use prior to 1918-19 by private water companies in Connecticut, the price charged per 1,000 gal. ranged from 25 ct. to 40 ct. with a majority of the companies charging 30 ct.

The amount of water required per family of 5, and its comparative cost at a fixture charge of $20.50 per year and at a metered rate of 30 ct. per 1,000 gal., is given below:

Gals per capita per day.	Gals. per day per family.	Total gals. per year.	At fixture rate of $20.50 per year. Cents per 1,000 gals.	At meter rates of 30 cents per 1,000 gals Dollars per year.
20	100	36,500	56.2	10.95
25	125	45,600	45.0	13.68
30	150	54,800	37.4	16.44
40	200	73,000	28.1	21.90
50	250	91,700	22.6	27.50

In the district studied, of 48 premises with single faucet only and accommodating 300 people, the average daily consumption was at a rate of 8.8 gal. per day per capita; of these 29 premises had a consumption below the average and 19 above that figure. Of the 29 below, 14 had a consumption [illegible] gal. per day or less per person and of the 19 above, 3 had a consumption of 12.0 or over.

These figures explain in some degree the low rates of water use given for European cities. It appears that without modern conveniences such as bath tubs, water flushed toilets and set tubs with running water, the average consumption of water per person per day is about 9 gal.

In full plumbed houses in this district, and by that is meant those having the conveniences mentioned above, 75 premises, accommodating 212 people, used an average of 28.4 gal. per day.

From the above analysis it appears that the cost of metered water ordinarily is cheaper to the consumer than by fixture rates and he is thus led to more lavish use. On the other hand, the general installation of meters tends to cut down waste of water. The net result of this combination may be that while legitimate household use of water seems to be increasing, the amount pumped or drawn from storage reservoirs is only slowly affected.

The relative consumption of water by months, days and hours is given in Figs. 1 to 3.

Table I shows the use of water in dwellings of various character and conditions of plumbing. That the use of water is concurrent with these peculiarities is plainly evident by a comparison of the relative amounts of water used in the several houses with the number and kind of plumbing fixtures. Besides the use of water by plumbing facilities the extensive use of automobiles also is a factor which should not be overlooked as it involves the continual washing oftentimes of several machines.

Table III gives a summary of the use of water in 661 premises of various kinds housing 5,937 people and is believed to be representative of average conditions in Hartford. As all of these premises are metered and have been for a number of years it is reasonable to presume that the use of water in them has become stable.

For mixed domestic use 35 gal. per capita seems ample at the present time. For estimate of 10 years hence 40 gal. per capita per day seems none too small.

The relative character of the houses can be readily observed in the amount of water used per person for domestic purposes. This does not mean entirely for personal consumption as in the case of the single faucet houses noted above, but it reflects the more lavish use of water for bathing, automobile washing, lawn sprinkling, etc.

Single dwellings average from 9 to 109 gal. per capita with ordinary use, as stated above, at a rate of about 35 gal. per capita per day.

TABLE I—PER CAPITA CONSUMPTION IN SINGLE HOUSES IN HARTFORD.

Location.	Assessed Valuation	Tank Closets.	Flush Closets.	Wash Basins	Bath Tubs	Set Tubs	Shower Baths	No. of People	Gals. Per Capita Per Day.
Asylum Av.	$45,000	10	*	9	7	3	2	9	133
915 Prospect Av.		1	*	4	1	3	*	4	88½
95 Washington	33,000	7	*	8	6	3	2	6	82
28 Warner	3,000	*	2	2	1	2	*	4	81
231 Washington	3,500	2	*	2	1	2	1	2	81
218 No. Beacon	8,000	1	1	3	2	3	1	4	75
50 Oxford	35,000	*	7	7	4	3	2	6	66
88 Fern	...	*	5	4	3	3	1	11	64
73 Capen	1,700	1	*	1	1	2	*	1	62
125 Barbour	1,500	1	*	1	1	2	*	4	60
140 Fern	13,000	3	*	3	3	2	*	5	58
20 Westland Av.	...	1	*	1	1	2	*	2	54½
20 No. Quaker La.	...	*	3	3	3	2	1	5	44
3 Harrison	2,800	1	1	2	2	2	*	7	30
30 Bushnell	1,500	1	*	1	1	2	*	4	26
36 Winthrop	6,000	2	*	1	1	2	*	[illegible]	25

*None.

TABLE III—DOMESTIC WATER CONSUMPTION IN HARTFORD

	Services	People	Cu. Ft. per Year.	Per Service People	Per Service Gallons per Day	Per Capita Gallons per Day
Apartment houses	9	462	1,391,300	51.4	318	62.0
6 tenement houses	76	1,602	1,957,000	21.0	536	25.5
4 tenement houses	66	828	1,145,100	12.5	355	28.4
2 tenement houses	208	1,543	2,268,100	7.4	223	30.0
Single houses, 3.	128	570	866,700	4.5	139	31.2
Single houses, 2	138	743	1,630,100	5.4	242	45.7
Single houses, 1	36	189	748,900	5.3	427	81.4
	661	5,937	10,040,500	9.0	312	34.4

The New Iron Removal Plant of Shelby, Ohio

A 1,000,000-gal. capacity iron removal plant for the city of Shelby, O., has been in operation long enough to show that it can successfully reduce the iron content of the raw water from 5 to 16 parts per million to less than 0.2 part per million in the filtered supply. A considerable reduction in the number of clogged meters and faucets has also resulted from the operation of the plant. A description of the plant was presented in a paper by Philip Burgess, of Burgess & Niple, Consulting Engineers, Columbus, O., before the annual meeting of the Central States Section of the American Water Works Association. The following notes are taken from the paper:

The plant consists of an aerator tower, sedimentation basin, filters and filtered water basin. The present plant was built to replace an outgrown one originally constructed in 1905. The supply is obtained from two dug wells approximately 15 ft. deep, and is pumped by electrically operated centrifugal pumps from either well to the top of the aerator, thence through the plant by gravity and again lifted by centrifugal pumps into the distribution system or standpipe under 60 lb. pressure.

The aerator tower is designed on a normal capacity of 17 gal. per square foot per minute. It consists of three horizontal trays 4.5 ft. by 9 ft. by 12 in. deep, with a 12-in. space between trays. The bottoms are covered by wire screen composed of iron wire .105 in. diameter spaced 3½ meshes to the inch. The coke particles vary from ½ in. to 3 in. diameter and make a layer 12 in. deep. The aerator is located over the inlet end of the basin and water is distributed over the top tray by two lines of perforated 8-in. cast iron pipe placed 8 ft. 8 in. above high water in the basin.

The sedimentation basin is 14 ft. by 43 ft. and 10.5 ft. deep and contains 47,300 gal., giving a nominal retention period of 66 minutes.

Two filters each containing 240 sq. ft. are designed to operate at the rate of 100,000,000 gal. per acre per day. The strainer system consists of 10-in. collectors and 1½ in. galvanized iron laterals spaced 6 in. apart. There are 12 in. of gravel, 24 in. of sand and 24 in. to the wash troughs.

The filtered water storage basin has a capacity of 250,000 gal. equivalent to 6 hours' storage. The filters are covered with a brick superstructure.

An unusual feature of the design is that high water in the clear well is 3 ft. above the bottom of the filters so that the total effective depth available for filtration is 3 ft., when the clear well is full. No controllers are provided in the effluent pipes on the filters. It is obvious that as the clear well becomes full, water backs up on the filters tending to reduce the head available for filtration and consequently to reduce the rate of filtration. This feature permitted considerable saving in the construction and operation of the plant. Moreover, the total head available for filtration has proven to be ample, notwithstanding the fact that it is customary to keep the clear well full.

The new iron removal plant was first placed in operation on March 19, 1920, and it has continued in successful operation since that time. It is of interest to note that the elimination of iron from the supply has been entirely satisfactory from the beginning of operation.

In general the iron content of the well water is high, ranging from about 5 to 8 parts per million in well No. 2 and 16 parts in well No. 1.

Analyses of the samples obtained from the supply to the filters indicate but slight change in the chemical and physical qualities of the water as effected by aeration. Later tests made by Mr. Roberts, Assistant Engineer of the State Department of Health, indicate that the dissolved oxygen content of the raw water was increased by aeration from 0 to 64 per cent saturation and that the free carbonic acid is decreased by aeration from 43 to 16 parts.

Analyses of the total iron content are of especial interest and indicate that the filtered water at times contains only a trace of iron in the samples. The highest iron content shown at the plant is 0.3 part per million and from the mains in March, was 0.4 part per million. The increase of iron in the main as compared with that in the filter effluents was caused by the former deposits in the mains. It will be of interest to see how long these deposits continue.

In general the operation of the plant has been entirely satisfactory and the filtered water [illegible] very clear and free from suspended [illegible]

Experience indicates that the [illegible] to become coated with deposits of [illegible] necessary to wash it every three or four weeks [illegible] washing the coke in place with a hose [illegible] of iron occurs in the reaction tank [illegible] only once or twice yearly and even at [illegible] but a few inches of deposited precipitate. [illegible] washed once daily at the rate of a little [illegible] per minute and generally for a period of [illegible]. The total quantity of wash water used is [illegible] per cent of the quantity of water filtered so [illegible] respect, the operation of the plant compares favorably with that of similar rapid sand filter plants provided [illegible] surface water supplies.

The total cost of the plant is around $[illegible]

Treatment of the Tannery Sewage Waste by Miles-Acid Process

Results of the treatment of tannery sewage waste by the Miles Acid process were outlined by Mr E S Dorr, Engineer in Charge Special Work of the Sewer and Sanitary Division of the Public Works Department of Boston, Mass., in a paper presented at the recent convention of the American Society for Municipal Improvements. The notes following are taken from his paper.

In June, 1916, a sample of tannery waste was submitted to the Miles-Acid process. The sample was very high colored and was heavily charged with organic and mineral matter, 6,449 PPM, of which 4,866 were mineral and 1,583 organic and volatile. Upon the application of sulphur dioxide the waste cleared in about five minutes and was well settled in half an hour. The dark blackish-red color was bleached to straw color, the SO_2 used was at the rate of 860 PPM (7,167 lb. per MG), probably 900 PPM (7,500 lb. per MG) would be advisable to secure sterility. Bacterial reduction was not noted.

The odor was completely killed.

The reduction in the organic and volatile matter, including suspended solids, was 50 per cent.

The precipitated sludge was at the rate of about 4 tons (dry) per 1,000,000 gal. with a grease content of 16.88 per cent and ammonia content of 7.50 per cent in the undegreased and 9 per cent in the degreased sludge. In pounds the amounts are 6,640 lb. degreased sludge, or fertilizer material, and 1,360 lb. grease.

The fertilizer with 9 per cent ammonia at $7.50 per unit (present value tannery tankage August, 1920) would be worth $67.50 per ton or 3.3 tons would be $222.75 per 1,000,000 gal.

The grease at the prices assumed in the New Haven investigation (and tannery grease is probably worth more) would be worth at 5 ct. per pound $68 and at 8 ct. per pound $108.80 per 1,000,000 gal. So that the total value of grease and fertilizer would run from $290.75 to $331.55 per 1,000,000 gal. treated, according to the quality of the grease.

On the other hand, the cost of operation would be high. About five times as much acid would be required, and twenty times as much sludge per 1,000,000 gal. would have to be handled as at the Boulevard sewer in New Haven. The cost of operation at that outlet was reckoned at $20.98 per 1,000,000 gal., of which $10.74 was for acidification. As the flow was not large, about 6,000,000 gal. per day, the New Haven figures may be taken as a basis for estimating the probable cost of handling tannery waste. Correcting in the ratios indicated above, for the heavier tannery waste, the cost per 1,000,000 gal. would be $161.22.

The values of the products have been figured above at from $291 to $331 per 1,000,000 gal. treated. The estimate therefore shows a surplus of values over costs of $130 to $170 per 1,000,000 gal.

Conference on Engineering Publicity. The American Association of Engineers has decided to hold a national conference on engineering publicity this winter. The conference will consider the general question of publicity for the engineering profession and devise plans for securing it. Feb. 25, 1921, has been set as a tentative date.

Regulation of Stream Flow in Delivering Stored Water from a Stream Bed Reservoir*

By H. H. JOHNSON.

Assistant Engineer, Shoshone Project, Wyoming.

The word "storage" when used in connection with a stream bed reservoir fundamentally implies stream regulation. Our dams are designed and constructed to conserve all the water possible, within necessary limitations, from the flood flow of perennial streams, and arranged with appurtenant structures to release this water for use at that time when it will be of the most benefit for agricultural purposes. Hence the regulation of the stream flow to properly deliver the impounded water economically and efficiently is a matter of great importance.

During the early stages of the Shoshone Project the regulation of the Shoshone River was of minor importance; there was an abundance of water for all purposes, and the Shoshone Dam was looked upon more as an item of interest to the tourist rather than as a tangible benefit to the development of a great community. However, as the project developed and the adjacent communities, also depending upon the Shoshone River for their water supply, grew, the benefits derived from this immense storage reservoir became more and more apparent until at the present time, with less than one-fourth of the project under cultivation, even the most skeptical will admit that without the Shoshone Dam and Reservoir there would be no Shoshone Project.

The project is located in the Shoshone River valley, its upper limit being about 80 miles above the confluence of the Shoshone and Big Horn Rivers. There are numerous prior water rights both above and below the project which must be protected and given due consideration in the regulation of the river flow from the Shoshone Reservoir. The principal source of supply is the melting snow from the high altitudes of the Yellowstone Park and adjacent mountainous country, the flow varying from 200 to 20,000 second-feet. The river forks within the Shoshone Reservoir site into two branches of about equal size, the stream beds of both being very steep. The Shoshone Reservoir is only about 75 miles from the headwaters of the river and the drainage area comprises about 1,700 square miles. These geographical features result in a quick run-off and a very short period of peak flow.

The water delivered from the Shoshone Reservoir is conveyed down the river channel for a distance of about 20 miles to the Corbett Dam. Here the portion required for project use is diverted into the canal system and the remainder passed for the use of prior appropriators. The dam is used as a compound weir in measuring the amount of water passed, the formula for discharge having been fairly well established.

The factors which must be taken into consideration in order to obtain a comprehensive regulation of the stream flow from a reservoir are numerous. Aside from inflow and outflow records reliable data should be kept relative to the reservoir evaporation and seepage losses. The accretion to flow below the dam site and the return flow from both underground and surface drainage of project lands, which can subsequently be used, should be determined as carefully as possible.

On this project it is possible to obtain all the inflow measurements from two rating stations, one on each fork of the river, any other accretions being so slight as to be disregarded. These stations are located far enough above the high-water contour of the reservoir to be well away from any effects which may be induced by back water, and all the work connected with them is done as carefully as possible in order that the results may be of the most practical value, as the data thus obtained form the basis for control at the dam.

The evaporation and seepage from reservoirs are factors which will vary with local conditions. In both cases, however, the loss must be stood by the reservoir, and no portion of it allotted to the lands where appropriations were made previous to the construction of the storage. In the case of a reservoir located as the Shoshone, the climatic conditions which affect evaporation are probably about an average. Even in this case the evaporation is in the neighborhood of 4,000 acre-feet per month during the irrigation season, which means a loss of about 130 acre-feet per day or very nearly 30 per cent of the minimum inflow which it can be readily seen is a factor not easily laid aside. The actual seepage losses are in most cases more or less indeterminate but in the case of the Shoshone and other stream bed reservoirs whose waters carry considerable silt, it is believed that after several years' operation the loss from this source is negligible. This factor, however, is more of interest from the construction than the operation standpoint.

---

*From the October issue of "Reclamation Record."

The important item in the delivery of water from a stream bed reservoir is the determination and the regulation of the quantity within reasonable limits. In the case where the natural river channel is used to convey the water to the project diversion works as well as the supply for prior appropriations, the quantity is such that the only method applicable to the measurement is the current meter, and the dam site does not offer many desirable locations for a gaging station. Nevertheless, all care possible was taken in choosing the station and an attempt made to obtain results which will compare in accuracy with the inflow measurements.

This project possesses a resource which will result in a material advantage when the ultimate development has been reached and the laws of supply and demand must be more carefully observed than at the present time, namely, the accretions and return flow to the river below the reservoir site. A short distance below the dam underground streams begin to appear as springs in the river bed. Until the past season no investigations have been made to determine the extent of these springs; but in order to regulate the river flow as was attempted this season, it was necessary to give some consideration to this matter. The only method of obtaining this quantity was by differential measurements above and below the springs, which were undertaken at the rating station below the dam used to determine the reservoir outflow, and at a station maintained about 5 miles below the springs. The results obtained in this way were very consistent and showed an accretion of about 40 cu. ft. per second, and it is assumed that this flow is constant throughout the year. This is the only flow entering the river from natural sources within the limits of the project, except, of course, the occasional run-off from local storms, which cannot be considered in connection with the stream regulation.

The river traverses about 25 miles of irrigated land, a very small portion of which is above the project diversion, practically all of the project lands draining back to the river. The return flow from underground and surface drainage from these lands, which can be again used for a supply to prior appropriations, therefore, is a considerable amount, and will be of great value to the Service when the project has reached that stage where further development will depend upon additional water supply. The return from surface drainage—that is, the waste from farm lands, canal system, and outflow of subsurface drainage system, of course, can be readily measured. The underground drainage, which appears as seepage along the river bank, is a quantity difficult to determine, and can be obtained only from differential measurements above and below the project lands. The amount of water thus returned, although relatively small in proportion to the total river flow, especially at high-water stages, must be given consideration. Undoubtedly in many cases it will be less than the error, which can be expected from current meter measurements, and results which can be relied upon can only be obtained from a long series of careful observations. The return from these sources varies directly as the amount of water applied to the lands and inversely as the river flow, as the maximum occurs during the peak of the irrigation season, when the demand for water is greatest and the river flow very nearly at its minimum; hence, we obtain the maximum benefit when most needed.

Some of these points may seem trivial when considered as factors affecting the flow of a river. As the project develops, the neighboring communities grow, and the demands for water increase, the necessity arises that all water possible be conserved. Before a comprehensive control of the river can be undertaken, information must be had of all the factors that contribute to its flow, and we must be prepared to defend any of our acts with reliable data.

It is not intended to convey the idea that we should attempt river regulation with that degree of accuracy which is practiced in a canal system; at its best, regulation can be obtained only within certain limits. Many factors enter over which we have no control, such as river losses, severe storms, etc. It is seldom possible to construct a reservoir to impound all the inflow and we have therefore at times the condition of spillway discharge, when of course regulation is out of our hands. Our important structures are so designed in many cases as to pass a uniform amount continuously, or, as in the case of the Shoshone Dam fitted with gates and valves working under high pressure. The smallest practical movement of these gates or valves may mean a change in discharge of from 50 to 100 second-feet. However, it is believed that the methods of control are usually such as to be within the limits of practical regulation when such regulation is necessary.

The benefits to be derived from our ability to regulate river flow were apparent to the settlers lying below the project land before the project itself considered the necessity. The original diversions for these lands were effected either by cutting canals into the river at places where natural channel conditions made diversion possible or by throwing up crude cribs or wing dams to serve as diversion works. At the time these were constructed there was always ample water to supply the rather slight demands. However, as these communities developed their demands increased, and at the same time the diversion for project use became greater. The result was that many of these old canals could not draw sufficient water from the river to meet requirements, not because of any deficiency in water to supply the appropriation but on account of the stream surface being too low to allow sufficient draft into the canal. Numerous requests were made of the Service in such cases to release water for the use of these settlers. When it became apparent that such requests could not be granted without payment for the water, steps were immediately taken to construct efficient diversion works. The result is that the Shoshone River is being fitted with up-to-date irrigation structures to replace the antiquated types originally used.

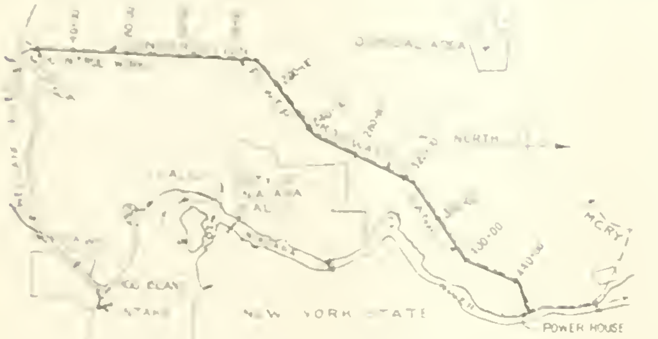
Another point which might be mentioned is the automatic regulation effected in the case of a severe storm above the reservoir occurring at the time of a peak flow, which is not unusual. The danger of serious damage resulting to irrigation structures in the stream bed below from an occurrence of this sort is considerably lessened by the intervening reservoir flattening out the peak and distributing the excess run-off over a considerable period of time.

As a concrete example of river regulation the conditions as they existed on the Shoshone Project during the past season may be cited briefly. The prior appropriations below the project amount to about 500 second-feet, which must be supplied if water is available from the natural flow. If the supply is below this requirement, the entire reservoir inflow must be rendered available for these prior appropriators, leaving the project to rely entirely upon stored water. It became apparent early in the season of 1919 that the natural river run-off would be very low. Water passed over the Shoshone Dam spillway but 28 days, reaching a maximum depth of only 1.1 ft.; this, combined with the discharge of a 42-in. blow-off pipe near the base of the dam, which is continuous throughout the year, gave a maximum flow of only about 2,000 second-feet. Investigations were immediately undertaken to determine the reservoir inflow and the amount of water which must be discharged over the Corbett Dam. During the time of minimum flow the Cody Canal above the Shoshone Reservoir, diverting from the South Fork of the river, used the entire flow of that stream and only about 10 second-feet reached the reservoir. The North Fork discharged about 215 second-feet. This entire amount, in addition to the increase of 40 second-feet from the springs below the reservoir, or a total of 265 second-feet, had to be delivered to the canals below the project, leaving only storage water for project use.

These investigations were not undertaken at this time with the primary idea of water conservation, as there was still an abundance of water for all purposes. But rather if requests were made for delivery to other than project lands, we would have data at hand for the determination of quantities and also to prepare ourselves for that time when, with the ultimate development of the project, water conservation and efficient delivery will be primary requisites for successful project operation. Negotiations were entered into early in the season for the delivery of Shoshone Reservoir storage water to lands on the lower reaches of the Big Horn River. This would have resulted in the regulation of the flow of two streams and the delivery of this water through about 200 miles of river bed.

Design Features of Queenston-Chippewa, Ontario, Power Canal

The power canal for the Queenston-Chippewa development will supply water for the ultimate development of [illegible] H.P., although the present installation is only one-half this amount. The plant is located on the Canadian side of Niagara Falls and is connected to the upstream side of the falls through the power canal 67,000 ft. long, including a portion of the Welland River 21,000 ft. in length. The actual design of the power canal involved an economic study to determine cross sections, slopes and lining to the canal which would yield the greatest net return in power developed. An account of this design was read before the Engineering Institute of Canada at their recent General Professional Meeting by T. H. Hogg, Assistant Hydraulic Engineer, Hydro-Electric Power Commission of Ontario, and the following is an abstract of the paper:



Plan of Queenstown-Chippewa Power Canal.

General Features of the Canal.– There are four sections of the canal. The first is the Welland River section which has a bottom slope of 0.000119 and side slopes of 2 to 1.

The earth section, which comes next, is 6,250 ft. long, with a bottom slope of 0.000120S, and is to be rip-rap lined, with finished side slopes of 1½ to 1.

For each of these sections a roughness factor of .035 in Kutter's formula was used. The earth section of the canal was originally designed as a concrete-lined section of much smaller cross-sectional area, but a study of the economic, constructional and operating conditions indicated that the advantages of the larger section with the rip-rap lining would be sufficient to compensate for the cost of the extra excavation. This portion of the canal has a capacity of over 15,000 c.f.s., with uniform flow at the assumed roughness factor of 0.035 and extreme low water in the Niagara River at Chippewa.

At the end of the earth section is located a transition 300 ft. long in which the trapezoidal cross-section is changed to the rectangular rock section of 48 ft. finished width, with concrete sides and bottom. Beyond this are the control works.

The rock section proper is 36,252 ft. long and is divided into two parts by the Whirlpool section, which has a length, including transition, of 2,450 ft. The rock portion of the canal has the the water section with concrete-lined sides and bottom with a finished width of 48 ft. The bottom slope is 0.0002113 and the roughness factor used in Kutter's formula was 0.014. This value is conservative in view of the proposed method of placing the concrete lining. With the steel forms that are to be used and the special provisions being made for alignment of the forms, a smooth plane surface will be obtained on the concrete facing.

For 12,500 ft. the concrete lining will be carried up 32 ft. above the finished grade of the canal, for the next 11,500 ft. the lining will be 31 ft. high, and for the remainder, 30 ft. high except in the Whirlpool section, where it is carried up to elevation 563. For the greater part of the time the water surface will be above the top of this concrete lining, but the friction loss will be reduced by the lower velocities that will then exist in spite of the greater roughness of the exposed rock. Numerous hydraulic studies have been made to determine the surface slopes in the canal for various discharges and for various water levels in the Niagara River. In cases where the water surface was above the top of the concrete lining a composite roughness factor was used in which the proportions of the wetted perimeter on the lining [illegible] rock surface were taken into account. Roughness [illegible] as 0.019 resulted in some of these instances.

The depth and slope of the rock section were fixed by an economic study, and the decision to use a concrete lining throughout its length was also reached in the same way.

An examination of the profile of the canal indicates that the rock surface falls far below the grade of the canal about Sta. [illegible], rising again to grade about Sta. 349. This occurs in the Whirlpool section, which is located at Bowman's Ravine (the Whirlpool Gully). Here it is necessary to carry the canal partly on fill and to use a trapezoidal cross-section on account of the foundation upon which the canal is carried. A concrete lining is essential on account of the high velocities. The bottom width is 10 ft. and the side slopes 1½ to 1. The slope of the bottom is the same as that of the rock section, 0.0002113.

The Whirlpool section of the canal was designed to have the same cross-sectional area at the lowest possible operating water level as that of the rectangular rock section. This minimum water level would be somewhat above elevation 542, which is the elevation of the curtain wall at the screen-house. The area of the cross-section below elevation 542 is the same for both, and for greater elevations the Whirlpool section has the greater area, so there is no danger of the canal capacity being "choked off" at this point.

In locating the Welland River section, the river course was closely followed so as to take advantage of the area of the natural channel. This necessitated leaving in all the bends that occurred in the unimproved stream. As the deflection of these curves is not great, they will not produce any appreciable loss.

The first important change in direction occurs at the beginning of the earth section at Montrose, and is followed by a second bend at the Michigan Central Railroad crossing at Montrose. In addition to these there are only five changes of direction in the rock section of the canal, the deflections of which are 51°, 27°, 31°, 33° and 46°. The radius of curvature in every case is 300 ft., and this radius is used for the inside and outside of the bend as well as for the center line, that is, the curves of the two sides and the center line of the canal are not concentric, resulting in a greater width of canal at the middle of the bend than at either end, the expectation being that the energy loss will be less than in a bend with concentric curves. It is probable that a shorter radius than 300 ft. would give even better results, but this minimum was fixed by the size of the electric shovels that are being used for the excavation of canal.

The question of surges of the water surface in the canal, due to changes of load on the plant, is of great importance. The sides of the canal and the floor of the screen house will be built to such an elevation that with the worst combination of conditions the water will always be contained within the sides of the canal.

It is essential that the canal shall deliver sufficient water to the power plant under most adverse conditions of water level in the Niagara River. The canal is, therefore, designed to deliver a quantity of water equal to its rated capacity when the river is at its lowest stage.

Observations of river stage at Chippewa have been available since 1902 and show a minimum of W.S. elevation of 558½, which low stage was reached only on two days. An examination of the past records of Lake Erie stage indicate that as low a stage as 558 may be possible at Chippewa. This latter water level is, therefore, treated as extreme low water, and the canal is designed to carry full load at this stage of the river.

While the low water conditions control the size and slopes of the canal, on the other hand the mean water conditions were assumed to be those on which the economic proportions should be based.

Procedure in Selecting Best Proportions for Canal Section. Certain limitations were met with at the outset. The Welland River section of the canal had to be maintained as a navigable stream, and as the excavation is in earth this portion of the canal was, therefore, designed for a low, non-scouring velocity. The minimum width of the rock section was fixed by the type of electric shovel used for excavating this portion of the canal and was placed at 48 ft.

The problem thus resolved itself into selecting the best proportions for the trapezoidal earth section and the best depth and slope for the 48-ft. rock section. The procedure in the latter case may be described as follows:

It is, of course, possible to design any number of canals

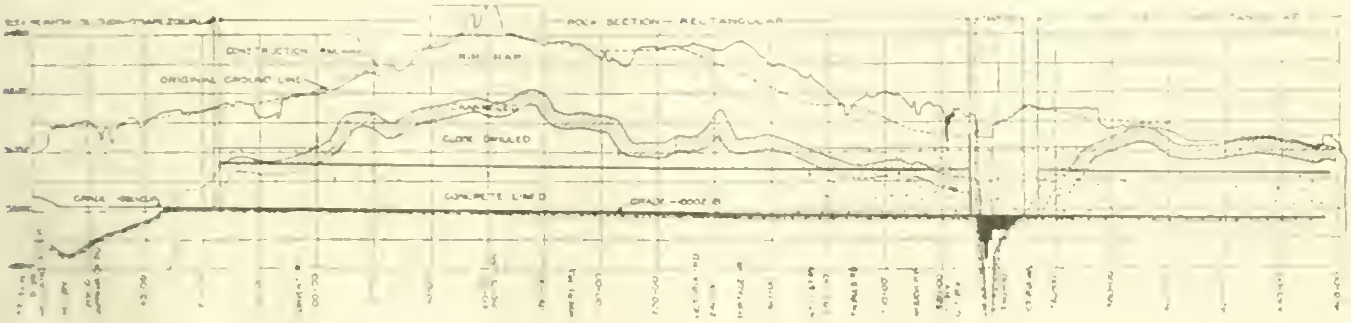
45 ft. wide, but with depth and slope varying so that all will give the same discharge at low water. For a low velocity the wetted cross-section must be deep, but its slope may be moderate. For a high velocity the depth of the wetted cross-section will be small, but the slope may be so great that the depth of the cut at the down-stream end may be greater and the total cost of excavating greater than for the low velocity design.

The procedure in determining the economic depth was as follows:

First, the design of a number of cross-sections for velocities of 3, 4, 5, etc., feet per second, the determination of the requisite slope of the bed in each case to give the full load discharge with uniform flow, and the determination of the variation in cost of these canals with low-water velocity.

Second, the determination of the friction loss in each of these canals with the river stage at its mean value. This friction loss represented so much lost power, which was, of course, small in amount for the lesser low-water velocities and greater as the low-water velocity increased up to a certain point.

Third, the plotting of the differential curves for items 1 and 2, thus showing the variation in delta cost with low-water velocity and the variation in delta power with low water velocity. From these two differential curves a third curve can thus be obtained, giving the value of delta-cost by delta-power plotted against low-water velocity. Thus there is obtained what will be called an economy curve, showing for any given low water velocity the rate at which further gains in power may be made at any low-water velocity by enlarging the canal slightly, and so cutting down velocity and friction loss.



Profile on Center Line of Canal from Welland River to the Niagara River.

Fourth, the selection of the best low-water velocity from this economy curve. This step will now be explained:

The gain in power which results from a slight enlargement of the canal comes as a result of the reduction in friction loss. The additional cost for power-house equipment is so small, within the limits in which we are working, that they can be neglected. It is reasonable, then, to continue the enlargement of the canal until the interest charges on the cost of excavation for the last horsepower gained are equal to the average value of the power from the whole plant, including interest, depreciation, operation and maintenance. By stopping short of this point we would be in a position to gain more power at a cost less than the average that we were willing to pay for the power from the whole plant. It is interesting to note that the economic velocity determined in this way is but slightly greater than the minimum cost at which the canal could be built to get the required discharge at low water. The minimum cost occurs for a velocity somewhat greater than the economic velocity.

The advantage for this method of attack is that it permits an economic size to be selected for the canal without the inclusion in the estimate of the cost of anything that does not vary with the low-water velocity. In this case the width of the rock cut being fixed, the earth excavation does not vary with the various designs for the rock section, and as a matter of fact, in computing the cost of rock excavation, only that below some assumed horizontal plane at a lower elevation than natural rock surface but above canal grade was considered.

The procedure in the economic design of the earth section of the canal was similar to that for the rock section, but somewhat more complicated by reason of the fact that certain changes in the design of the earth section involved changes in the excavation throughout the length of the rock section. The difference in [illegible] largely a matter of properly taking care of [illegible] in cost.

Relation of Engineering to Drainage*

By S. H. McCRORY

Chief, Drainage Investigations, U. S. Bureau of Public Roads

In our dealings with drainage projects we find in a few places there is still a tendency for the officials of the districts to take over in part the duties of the engineer and to make him a figurehead. Yet even in the Middle West there is still a great lack of appreciation of the drainage engineer.

"All I want of an engineer is to set the grades."

Let me say here that this is not the random remark of an ignorant tenant farmer nor yet that of an inexperienced country lawyer.

"All I want of an engineer is to set the grades. I dont take much stock in the theoretical knowledge engineers get out of books. As to the size of tile or ditch needed to drain a particular watershed, I would rather have the opinion of three or four hard-headed contractors, men of experience."

No, this is the verbatim remark of the head of a prominent law firm in one of our most progressive Middle Western States, legal adviser in many organized drainage districts, and president of a large national bank. Presumably it represents truly his grasp of the relation of engineering to drainage. It sums up his appreciation or rather lack of appreciation, of the great hydraulic principle involved in any sizable drainage project—principles on the correct application of which the project will stand or fall, be successful or unsuccessful. From these few words one can readily judge this eminent lawyer's estimate of the relative importance of the engineering to the other considerations of a drainage project; from them, also, one can predict, so far as the views of this lawyer shall prevail, the outcome when these considerations clash.

Let no one here construe my words as reflecting upon the usefulness of the so-called "practical" man. The world has great need of him and no one more than I admire his peculiar—and often uncanny—property of "getting results." In the rough and ready engineering of war or other emergency he oftentimes shines at the expense of his technically-trained brother.

The Swivel Chair Lawyer-Engineer. Nevertheless, I maintain that where the matter of a few feet in depth or width of a ditch, or of a few inches in size of tile means the success or failure of a project, means economy as against wasteful extravagance, then, I maintain, it is due the people footing the bill that the most deliberate judgment be applied, and that judgment be applied by men trained to exercise it in strict accordance with the hydraulic and engineering principles involved.

What would we think of the man who, after estimating the width of the Mississippi River should proclaim himself prepared to state the dimensions of the members of a bridge to span the river? Who will say with respect to a birdge, "All I want of an engineer is to stake out the location of the piers, etc.?" Yet, many drainage districts are content to let their officials go on the ground and locate a ditch and fix its depth and width, with no information as to the quantity of water their ditch will carry, nor as to the quantity it should be made to carry. Ofttimes lawyers do not find it even necessary to have their sa[illegible] [illegible] problems off-hand. Too often are the [illegible] fixed with sole regard to the amount [illegible] owner wishes to spend that money [illegible] being thrown away. All too frequently, to[illegible] sections of a levee located in accordance [illegible] of the adjoining landowner instead of with [illegible] the floodway required.

---

*From an address Nov. 16 before the National Drainage Congress.

The attitude of mind which has [illegible] as regards the hydraulics of a drainage project [illegible] after all, a natural one. Our grandfathers [illegible] and undisturbed by thoughts of "cubic feet per [illegible]" or "inches per square mile." A ditch was a ditch, to be [illegible] and perhaps later to be enlarged if found too small [illegible] then forgotten. That was all well enough for that day and age when the drainage question was an individual one. The world has moved on since then, however, population has increased; land is worth dollars where formerly it was worth cents, and drainage has become a community problem which, if the community is to have the benefits to which it is entitled, must be treated with the same scientific intelligence as, for instance, is accorded the sewage and water problems of our cities. In a project where hundreds of thousands, even millions, of dollars for construction alone are at stake—to say nothing of the inestimable sums representing expected benefits, is it not folly, or worse, for the district to fail to avail itself of the benefits of the most advanced drainage engineering practice?

What Is a Drainage Engineer? Originally the term civil engineer was loosely taken to include all engineers who were not military engineers. Specialization set in, however, and soon the terms mechanical engineer and mining engineer were recognized, and more recently, electrical engineer, sanitary engineer, railroad engineer, highway engineer and many others—and the end is not yet. The science of drainage engineering is one of the more recent of the offspring from the parent, civil engineering. It is quite obvious, then, that a civil engineer is not necessarily a drainage engineer. A drainage engineer must of course be conversant with the theory and practice of surveying; he should have an "eye" for topography; that is, the ability to recognize an inspeetiion the drainage characteristics and possibilities of a tract; he should be familiar with construction methods and devices; he should understand the legal procedure; and a knowledge of soils is highly desirable. Yet I contend that a man may have all these attributes and yet, lacking one vital qualification, not be a drainage engineer in the full sense of the word. He must know hydraulics. He must be able to apply true hydraulic principles, especially those as relate to open channels and pipes.

How many projects, in other respects well handled have failed in their purpose owing to ignorance or disregard of the hydraulic features involved? How many more such monuments to our stupidity or false sense of economy shall we erect before we shall learn that success and failure hinge on correctly answering these two questions: How much water have we got to carry? How shall we carry it? These questions are not simply answered; they do not permit of offhand guesses; they are vital and fundamental questions that justify the most careful and conscientious study that can be brought to bear upon them. It is essential that engineers with broad drainage experience be employed to solve them, and that they be allowed to work unhampered. In one instance that I recall the Board had ordered the engineer to change his plans four times, the change in each instance being to reduce the size and depth of the ditches. After the drains were constructed according to the revised plans, they did not work. It was found necessary to redig the entire project and to give it practically the dimensions originally planned. The cost to the landowners nearly doubled.

Drainage Engineering a Comparatively Recent Development.—There was a time—and that not so long ago—when the "hit and miss" method of planning drainage improvements was perhaps justified on the plea that competent engineering advice was not available. No such plea can properly be advanced now. The field of the drainage engineer is at the present time recognized and provided for in many of our colleges and universities. Competent drainage engineers are available to any drainage district whose officials have sufficient breadth of mind to realize the worth of sound engineering as a basis for their project, and to abandon the [illegible] and [illegible] foolish attitude. If in employing [illegible] more attention was given to the drainage work that [illegible] engineer has done and the success that he has attained [illegible] to the question of securing the engineer at the lowest possible cost, better work would be secured. In hiring an engineer for drainage work, experience with drainage projects is most desirable. An electrical engineer or a chemical engineer may be highly competent in his own line, yet make a sad botch of a drainage project.

"Flow of Water in Concrete Pipes."—The results of a study of concrete pipe by irrigation engineers of the U. S. Bureau of Public Roads are given in a professional paper published on Oct. 28 by the U. S. Department of Agriculture as Bulletin No. 852, "The Flow of Water in Concrete Pipe." The author is Fred C. Scobey, senior irrigation engineer. The bulletin is based on field tests made on pipes in commercial operation, and in addition contains abstracts of experiments made by agencies other than the Irrigation Division. It is illustrated by photographs showing various forms of concrete pipe construction. The bulletin is intended for the use of engineers designing and measuring concrete pipes for irrigation, power, mining, municipal or other purposes, and for courts and lawyers interested in cases involving questions as to the carrying capacities of concrete pipe. Copies of the bulletin can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 25 cts. each.

Personals

Thomas Cloney, formerly city clerk, has been appointed city manager of Vicksburg, Mich.

John F. Ohmer, Jr., Mechanicsville, Ind., has been commissioned a first lieutenant in the Engineer Corps, U. S. Army.

J. H. Rayburn has resigned as city manager of Chadron, Neb., to become secretary of the Commercial Club of Salt Lake City, Utah.

Maj. M. Elliott, Corps of Engineers, U. S. Army, has been appointed district engineer of Wheeling, which place has been vacant since the transfer of Col. C. W. Otwell to the chemical warfare department.

William W. Coblentz, physicist in the U. S. Bureau of Standards, has been awarded the Janssen medal by the French Academy of Sciences for his discovery in connection with "rays emanating from the earth and stars."

Francis S. Shields, secretary of the Sewerage and Water Board of New Orleans, La., since its organization in 1899, has resigned because of ill health. He is succeeded by A. G. Moffat, who has been assistant secretary since 1903.

Archibald C. Barrett, who has been assistant city engineer of Marshalltown, Ia., for the past 18 years, has sailed from New York for Callao, Peru, where he goes to be concentrator superintendent of a stamping mill owned by the Cerro de Pasco Copper Corporation.

W. C. Hawley of Pittsburgh was re-elected president at the annual convention of the Pennsylvania Water Works Association. Other officers are: First vice-president, W. H. Miller, Jr., Reading; second vice-president, S. W. Smith, Port Allegheny; third vice-president, Edgar Munson, Williamsport, and secretary-treasurer, F. S. Purviance, Pittsburgh.

J. W. Lynch, superintendent of the gas plant of the Philadelphia Suburban Gas & Electric Light Co., Pottstown, Pa., has resigned to accept the managership of the Hagerstown, Md., Light & Heat Co. He took charge Dec. 1, succeeding R. C. Saylor, who has accepted a position at Johnstown, Pa. Mr. Lynch was formerly manager of the Bucks County Public Service Co., Newtown, Pa.

Obituaries

Charles B. Kelly, of the firm of Thomas Kelly & Sons, contractors, Winnipeg, Man., died Nov. 25, aged 33 years.

Daniel J. McNichol, formerly a member of the McNichol Contracting & Paving Co., Philadelphia, Pa., died Nov. 29, aged 54 years.

James J. Reynolds, consulting engineer of the Elgin, Joliet & Eastern Railway and consulting engineer of the Illinois Steel Co. during the construction of its $100,000,000 steel plants in Gary, died Nov. 29 at his home in Chicago after a three-day illness. He was born in Cincinnati 65 years ago.

Harold Tait, an engineer in the employ of the Borough of Queens, New York City, died Nov. 29 from pneumonia at his residence, 353 West 57th St., New York City. He was born in Metuchen, N. J., and was educated in Rutgers College. He went to Long Island City in 1897 as an engineer under the General Improvement Commission.

Industrial Notes

Henry F. Pratt has been appointed mid-western sales manager of the Taylor-Wharton Iron & Steel Co., and its subsidiaries, with office located at 502 Denham Bldg., Denver, Colo.

Howard K. Ihrig, formerly chief draftsman, Engineering Works Department, Dravo Contracting Co., Pittsburgh, Pa., is now in charge of the engineering department of The Heltzel Steel Form & Iron Co., Warren, O.

Charles Lyman Rand, secretary and chief chemist of the Mitchell-Rand Mfg. Co., New York, manufacturers of waterproofing compounds, etc., has relinquished his duties as factory superintendent to devote his entire time to important research work in the chemical and allied fields of his company. He will be succeeded as factory superintendent by Joseph T. Lawrence, chemical engineer, formerly associated with E. I. du Pont de Nemours & Co.

Railways and Excavation Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm. 4[illegible]3 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office: Room 415 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation (c) Quarries and Pits
(b) Management and Office System (d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings (d) Miscellaneous Structures
(b) Bridges (e) Properties of Materials
(c) Harbor Structures (f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., DECEMBER 15, 1920. Number 24.

The Perils of Labor Union Restrictions

Chicago newspapers have been giving publicity to the fact that the Carpenter Contractors' Association and the carpenters' union have an agreement under which "millwork" made in non-union mills can not be used. This restriction is being fought in the courts, not by any contractor but by an open-shop mill.

It is to be regretted that Chicago carpenter contractors ever put their names to an agreement of this sort, but it is a matter of greater regret that it was not a contractor but a mill owner that sought to break this combination in restraint of trade.

While we sympathize with the desire of manufacturers to protect themselves from cut-throat competition, and while we also sympathize with union carpenters in their desire to strengthen the power of unions generally, we regard such methods as the one under discussion as being indefensible.

Prior to the world war labor unions in Great Britain had attained such strength, and had exercised that strength in such arbitrary and uneconomic ways, that British manufacturers were finding it increasingly difficult to compete with America and Germany. It could not be contended that British unions had secured higher wages than prevailed in America, or even in Germany, nor could an outsider discover any essential gain that had resulted to their members as a result of their restriction of output, limitation of apprentices, or opposition to labor-saving machinery and piece-work payment. In fact, compared with American workers, only 10 per cent of whom are unionized, the British workers have long been very poorly paid. But they have remained blind to this significant comparison, and true to their faith in the power of labor unions to accomplish good by coercive methods to which nearly all men outside of such unions object. Doubtless this blind faith of theirs can be traced to certain fallacies, for it can not be attributed to any substantial gains that they can adduce in support of their coercive acts.

The prime fallacy appears to flow from the conception that workers secure only a very small fraction of what they produce. According to Prof. King (see his Wealth and Income) about 75 per cent of American annual income goes to the workers and 25 per cent to capitalists. It is probable that a similar ratio exists in Great Britain. Where any such ratio exists it is evident that wages can not be greatly increased by any action that does not result in a general increase of productivity per worker.

In his article on "Prices" in our issue of April 7, Mr. Gillette showed that annual per capita productivity in America had doubled in the 40 years between 1869 and 1909, and that average wages had doubled in the same period when expressed in terms of what the wages would buy. This was undoubtedly the result of invention, and education, for the most part, and scarcely at all the result of labor union activities. Had American labor unions been able in 1869 to take away from capitalists their entire share of the income, it is doubtful whether they could have increased the income of the average worker 30 per cent, and then only temporarily. Fortunately, for their own good, our workers were so poorly organized in 1869 that they were unable to suppress the action of competition among employers, and thus left their employers free to launch one experiment after the other, in the hope of securing large profits. For every invention that was promoted successfully, scores failed, but the net result was a steady increase in American productivity in field, mine and factory, and an equally steady rise in real wages. Dollar wages did not rise as fast as real wages (that is, the commodities that wages buy), because the commodity price level was falling, and continued to fall till 1896; but the real wage of the average worker increased 100 per cent in 40 years.

Then about 1909 real wages ceased to rise, largely because the eight-hour day began to make its effect felt in decreased daily output, but partly because the growing strength of American labor unions was leading to restrictions of output and opposition to labor-saving machines and methods. The eight-hour day was itself a labor union product, and it has cost the workers of America a decrease of real wages equivalent to about 25 per cent below what they would now be enjoying; but this is probably not to be [illegible], since the average man preferred more leisure to more dollars. The point is that the two hours subtracted from the ten hour day was subtracted from the real wage of the average worker. To have taken it from the income of the capitalists would have amounted to taking their entire income.

Without resorting to the use of [illegible] data, or by the use of incorrect data any economic theory can apparently be shown to be true. The motto of every earnest student of economics—practical or otherwise—should be "Get the data," for all argument ends when correct and [illegible] quantitative facts are presented. Indeed economic arguments usually end under no other condition.

Teach All Employes to Become Investors

Our allies in the recent war owe our government $10,000,000,000. They can repay it only in goods, for their gold reserves are already below a safe limit. But if they begin to make a serious effort to pay off their debts in goods, it is probable that we shall raise a tariff wall against them, in order to protect our manufacturing industries. Already there is talk of shutting out Canadian wheat because it is competing with American wheat.

The ten billion dollars that the allies owe us represents goods that we sold to them. They have the moral right to repay us in goods. But international ethics is a weak reed to lean upon. The first serious inroad that British or French textiles make upon our markets will be speedily followed by a cry from our textile manufacturers for "protection against foreign cheap labor"; and the cry will doubtless be heeded by Congress.

Although nations are often likened to individuals engaged in trade, there are several marked differences. An individual can sell his service or his goods to whomever he wills, and he can buy with equal freedom within his own country. But nations do not, as a rule, either buy from or sell to other nations; they merely permit their citizens to trade with the citizens of other nations, usually under restrictions. The result is that when one class of producers in a nation finds itself unable or unwilling to sell at prices as low as are offered by foreigners, that class of producers makes such an outcry that the government feels impelled to rush to its assistance.

American farmers are now talking of asking the government to assist in extending additional credit to Europeans, so that our cotton, grains, etc., can be marketed at profitable prices. But if two billion dollars of credits were thus provided, when and how can the two billions be repaid? If we ship raw cotton to Germany are we prepared to admit to America cotton fabrics made in Germany, and thus throw still more of our textile workers into idleness? A plan that would help our cotton farmers would be injurious to our textile mill hands. And so it goes through all our industries where foreign trade involves heavy imports of things that we already produce in large quantities.

Nearly two thirds of the average workman's income is spent for food and clothing, both of which are produced in abundance in America. If all our workers are to be kept employed profitably, it is obvious that they must be induced to buy a larger percentage of things other than food and clothing. No gain will come to them, as a whole, by merely trading with foreign countries for food and clothing, because the result will be to throw American workers out of jobs. As the country is now about to resume its march of economic progress, adding probably 2 per cent annually to the per capita productivity, it is imperative that an increased demand be coincidently developed. It will be futile to look to foreign markets to absorb much of our increased production, not only because they can give us in return relatively little that is not produced here, but because it upsets our own productive system to import the sorts of things that we already produce. Obviously, then, we must cultivate a home demand for our increased output; but since we are nearing the limit as respects home demand for food and clothing, the new demand must be directed toward other things.

Chief among the things really needed in America are better transportation facilities, more and better buildings, and better education. Several billions of dollars could be annualy absorbed in these three fields to great advantage, in addition to the sums now being spent. Several million workers should be diverted from factories and farms to construction work and to mills producing structural materials. Several hundred thousands of men should be diverted to the practice of teaching, not only in schools and colleges but in factories and on farms; for our knowledge of how to do things economically has far outrun the practice of it by the average producer.

Does it not devolve largely upon civil engineers to lead the way in educating the public in matters relating to construction necessities? We use the word necessity in a relative manner. The country can exist without more roads or railways, and without more buildings. But since it has a surplus of producing capacity for present needs, the wisest application of that surplus energy becomes a necessity—an economic necessity, as distinguished from an absolute necessity.

Employes of railways should be taught to invest in railway stocks and bonds. Public employes and others should be taught to invest in public bonds. In general there should be conducted a thrift campaign intended to induce workers to invest annually fully 10 per cent of their incomes in good securities. Hitherto we have secured such investments almost entirely from the so-called "wealthy class." The time has come to induce every wage and salary earner to become an investor.

Book Reviews

Railway Surveying and Permanent Way Work.—By S. Wright Perrott, M. A. I., M. Inst. C. E., Professor of Civil Engineering in the University of Liverpool, and F. E. G. Badger, A. M. Inst. C. E., formerly Permanent Way Engineer with the London & Northwestern Ry. Co. Edward Arnold, London, and Longmans, Green & Co., New York. 6x9 ins.; 303 pages; illustrated. $10.50 net.

The authors of this new work have gained their experience on the staffs of leading English railways and in other railway work abroad, and have produced a very creditable volume in that it appears to reflect the best English practice. The chapter headings are as follows:

I Classification of Railways.
II Railway Exploration or Reconnaissance.
III Reconnaissance in Tropical Countries.
IV The Preliminary Survey.
V Office Location.
VI Field Location.
VII Location.
VIII Transition Curves.
IX The Spiralling of Existing Railway Curves.
X Railway Surveying in the United Kingdom.
XI Setting Out Work for Construction.
XII Permanent Way.
XIII Permanent Way (cont.).

Chapter III contains a variety of suggestions which should be useful to engineers beginning survey work in the tropics. Chapter VIII is an unusually full treatment of the subject. The two chapters on Permanent Way should be of especial interest to American engineers who may desire to compare American and English practice, as they contain many references to standard English methods.

An appendix on "Transit of Big Loads" contains many valuable points, although necessarily applicable chiefly to English rolling stock.

An excellent feature of the book is the number of illustrations, including numerous inset sheets containing various maps, drawings, tables and diagrams.

Railroad Curves and Earthwork, with Tables, by C. Frank Allen, Professor of Railroad Engineering at the Mass. Institute of Technology; sixth edition, revised; McGraw-Hill Book Co., New York; 219 pages text, 289 pages tables; $4.00.

This latest edition of this well known engineer's manual for railroad field work has some modifications and additions in line with latest practice and in order to accommodate its use to certain features of highway work and earthwork computation, some entirely new material has been added from practice in valution work, as also a few pages on "haul."

In connection with Chapter XII, it is believed that from the standpoint of the student, an extra page or so devoted to a numerical problem involving the use of the prismoidal formula with the computing of the "mid-section," would make more clear a matter too often obscured in algebraic equations.

The Field and Office Tables remain as in the previous edition, a very excellent collection. It is hoped that the author will see fit to add another table, however, in a later edition, a table which would certainly be of as much use as many of those present, a table on "Minutes in Decimals of a Degree."

Such a table, for ready reference, should be say Table II [illegible] the collection

The book as a whole is of a high order and is deserving of wide use. The author is to be complimented on his efforts in keeping it up to date.

Engineer Members of State Public Service Commissions

To the Editor: Referring to your editorial "Why Engineers Should Formulate Economic Public Policies and Programs," in your issue of Oct. 6, 1920, I am enclosing copy of a tabulation received from the Engineering Council relating to the number of engineers who are members of Public Service Commissions in the United States. You will note from it that the engineers make a very poor showing.

B. F. JAKOBSEN, Designing Engineer
Fresno, Calif. San Joaquin Light & Power Corporation

Table showing states having public service or other regulatory commissions, number of commissioners on each and number of these commissioners who are members of a leading engineering society. Compiled by Edmund I. Mitchell, Engineer Assistant, with the aid of Engineering Societies' Library:

State and title of commission	No. of commissioners	No. having membership in Am. Eng. Soc.
Alabama P. S. C.	[illegible]	0
Arizona Corp. Com.	[illegible]	0
Arkansas Corp. Com.	[illegible]	0
California R. R. Com.	[illegible]	0
Colorado P. U. C.	[illegible]	0
Connecticut P. U. C.	[illegible]	1
Delaware none		
District of Columbia P. U. C.	[illegible]	1
Florida R. R. Com.	[illegible]	0
Georgia R. R. Com.	[illegible]	0
Idaho P. U. C.	[illegible]	0
Illinois P. U. C.	[illegible]	1
Indiana P. S. C.	[illegible]	0
Iowa Bd. R. R. Com.	[illegible]	0
Kansas Ct. Ind. Relations	[illegible]	0
Kentucky R. R. Com.	[illegible]	0
Louisiana R. R. Com.	[illegible]	0
Maine P. U. C.	[illegible]	0
Maryland P. S. C.	[illegible]	0
Massachusetts Com. Dept. P. U.	[illegible]	0
Michigan P. U. Com.	[illegible]	0
Minnesota R. R. and W. H. C.	[illegible]	0
Mississippi R. R. Com.	[illegible]	1
Missouri P. S. C.	[illegible]	1
Montana Bd. R. R. C. and P. S. C.	[illegible]	0
Nebraska Rway. Com.	[illegible]	0
Nevada P. S. C.	[illegible]	1
New Hampshire P. S. C.	[illegible]	1
New Jersey Bd. P. U. C.	[illegible]	0
New Mexico Corp. Com.	[illegible]	0
New York—1st District P. S. C. (see foot note)	[illegible]	0
New York—2nd District P. S. C. (see foot note)	[illegible]	0
North Carolina Corp. Com.	[illegible]	0
North Dakota Bd. R. R. Com.	[illegible]	0
Ohio P. U. C.	[illegible]	0
Oklahoma Corp. Com.	3	0
Oregon P. S. C.	[illegible]	0
Pennsylvania P. S. C.	7	0
Rhode Island P. U. C.	[illegible]	0
South Carolina R. R. Com.	[illegible]	0
South Dakota Bd. R. R. Com.	[illegible]	0
Tennessee R. R. and P. U. C.	[illegible]	0
Texas R. R. Com.	[illegible]	0
Utah P. U. C.	[illegible]	0
Vermont P. S. Com.	[illegible]	0
Virginia Corp. Com.	[illegible]	0
Washington P. S. C.	[illegible]	0
West Virginia P. S. C.	[illegible]	0
Wisconsin R. R. C.	[illegible]	0
Wyoming P. S. C.	[illegible]	0
	[illegible]	[illegible]

Abbreviations—
1. Bd. R. R. or P. U. C.—Board of [illegible] Public Utility Commissioners
2. Com. Dept. P. U.—Commissioner of the Department of Public Utilities
3. Corp. Com.—Corporation Commission
4. Ct. Ind. Relations—Court of Industrial Relations
5. P. S. C.—Public Service Commission
6. P. U. C.—Public Utilities Commission
7. R. R. Com.—Railroad Commission
8. R. R. & W. H. C.—Railroad and Warehouse Commission
9. Rway. C.—Railway Commission

Foot Note.—New York P. S. C. for 1st District [illegible] headed commission. Commissioner has three deputy commissioners as assistants.

The above table was compiled as follows: The name of each commissioner was obtained from Public Utilities Reports, Annotated, 1920 A; Henry C. Spurr, Editor Public Utilities Reports, Rochester, N. Y., publisher. Then each name was looked up in the 1920 Year Books of the American Society of Civil Engineers, the American Institute of Mining & Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Automotive Engineers.

Facts, Figures and Opinions Regarding Railroad Electrification

The immense audience [illegible] gathered in the auditorium of the United Engineering [illegible] Building in New York City on Oct. 22 demonstrated a [illegible] interest in heavy electric traction, the topic [illegible] steam and electrical engineers together on the occasion. Under the general direction of E. B. [illegible], New York Central R. R., with the cooperation of [illegible] of the A. S. M. E. and the A. I. E. E., a program of papers was presented containing information of the kind needed to permit a correct estimate to be made of the present status of the subject. The material was set forth in carefully prepared papers presenting alternately the respective merits of steam and electric locomotives, one might almost say in debate form.

The proceedings differed from an orthodox debate in that the papers were all prepared in advance, there was no decision rendered on the merits of the presentation and of the question itself by a board of judges, and each side, more or less admitted the other to have some ground to stand upon. As the discussion proceeded the need for a cooperative effort to determine the conditions under which electrification is desirable became increasingly evident.

While there will always be differences of engineering and economic opinion regarding the wisdom and practicability of electrifying a given section of track, there ought to be no difference in the aspects of the facts involved. In other words, a fact ought to look the same to an electrical or a mechanical engineer whether he is connected with the operating or the manufacturing side of railroading. The engineer of either type is apt to be prejudiced in favor of the apparatus which he most admires and most fully understands. Again, the manufacturer has something to sell, whereas the operator has much capital tied up in existing equipment and in the development of present practices, which he does not wish to disturb. Each needs general information to offset his own bias. The most helpful function which a meeting like that held in New York can perform is, then, what might be termed the "mitigation of prejudice," or, maybe better, the "stimulation of tolerance." It is to be hoped that some such result will follow and that it will take tangible form.

In getting together the first step is to agree upon a few salient principles or facts. There are some sections of some railroads that obviously are not suitable for electrification, while others ought to be electrified at once, even in the present state of the money market. The reasons in both extreme cases are easy to find. Between these extremes are zones of less definiteness, gradually approaching a region of doubt. There are, in each case, certain controlling factors, or "peremptory" factors as they are termed by C. O. Mailloux in an address delivered at the International Electrical Congress at Turin as far back as 1911. Why could not these factors be listed for present and prospective electrifications by a group of competent engineers, say by a composite committe made up of appointees of the railroad and engineering societies? This would not be a formidable task and the result would constitute a piece of really constructive work.—Editorial in the Electric Railway Journal.

Treated Cross Ties in 1919. During 1919, according to the 1920 Proceedings of the American Wood Preservers Association, a total of 139,878,584 cu. ft. of wood was subjected to preservative treatment in the United States. More than 80 per cent of this quantity, or 112,703,781 cu. ft., consisted of cross ties. The kind of wood and number of cross ties treated in 1919 were as follows:

Kind of wood.	No. treated.
Oak	15,082,530
Yellow pine	11,896,820
Douglas fir	4,085,950
Western pine	1,641,265
Beech	2,046,958
Gum	7[illegible]9,251
Tamarack	28,921
Maple	1,126,480
Birch	61,571
Elm	1[illegible]3,500
Hemlock	15,[illegible]
All others	117,[illegible]
Total	37,567,927

In treating ties with creosote, the average injection was 8.04 lb. per cubic foot and with zinc chloride, 0.48 lb. per cubic foot. With the zinc-creosote emulsion, the average injection was 0.50 lb. of zinc and 3 lb. of creosote.

Economical Loading of Sea Going Dredges

The correct determination of the relative economy of time to be spent in dredging and in running to and from the dumping grounds is a matter of some importance. It may be investigated from a theoretical standpoint, and the ideal practice for particular cases determined, but judgment is essential when it comes to applying practically some of the theoretical conclusions.

An interesting discussion of this subject is given in the November-December issue of The Military Engineer by Mr G. S. Phelps, U. S. Assistant Engineer, of the Cleveland, O., District. His article follows:

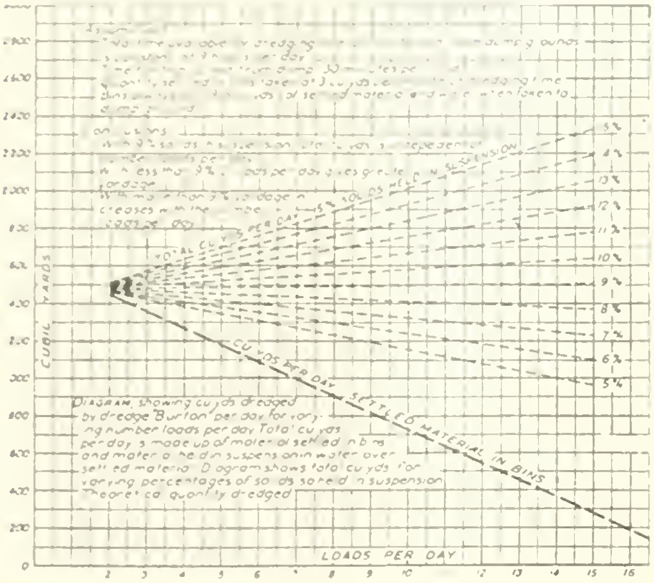


Fig. 1—Yardage Dredged Per Day for Varying Number of Loads.

Investigation was made as to the number of loads per day which should be dredged at Cleveland Harbor with the seagoing hopper dredge Burton. At this harbor dredged material running overboard with the overflow is a waste of money, as it settles within the dredged area. The material was a fine silt, which settled slowly in the bins. The time required for one round trip to the dumping grounds was about 30 minutes. The total time available for dredging and dumping is assumed at 9 hours per day. Two loads per day could be dredged with a pumping time of 4 hours each, which with the two trips to the dumping grounds consumed the 9 hours. While the dredge worked on that schedule, it was found that a fairly constant average of about 720 cu. yd. of settled material in the bins was secured with each load, or at the rate of 3 cu. yd. of settled material per minute of dredging time. Capacity of the bins was 935 cu. yd.

The dredging time per load was varied from 30 minutes to 4 hours, and it was found that the amount of settled material in the bins was practically constant at 3 cu. yd. per minute of dredging time, irrespective of the length of the dredging period. Thus when 6 loads per day were taken, the total time dredging was 6 hours, 3 hours were spent going to and from dumping grounds, and the quantity of measured settled material in the bins was about 1,080 cu. yd. for the day, still 3 cu. yd. per minute of dredging time.

The question arose as to whether the solids held in suspension in the water above settled material in the bins were sufficient to justify the greater number of loads per day. The settled material had fallen from 1,440 to 1,080 cu. yd. per day. It is apparent that volume of dirty water carried to the dumping grounds was increased from 2 (935) — 1,440 = 430 cu. yd. with 2 loads per day to 6 (935) — 1,080 = 4,530 cu. yd. with 6 loads, an increase in volume of water carried of 4,100 cu. yd. The loss in settled material was 360 cu. yd. If the water contained 8.76 per cent solid material held in suspension, then the loss in settled material was exactly balanced by the gain in suspended solids; if less than 8.76 per cent, 2 loads per day gave the greater total of settled and suspended material. If more than 8.76 per cent the shorter dredging period and greater number of loads were better.

It appears then that in this case, 8.76 per cent is the critical percentage of suspended solids at which economy definitely demands a change from a policy of full loading of bins to one of many loads per day, the more the better, limited only by the time required to fill bins with muddy water. Satisfactory sampling of the water held in bins has not been made, since the dredge left the work before this was done. It is believed, however, that in a great many cases where the material consists of fine silt, the solids held in suspension will considerably exceed this critical percentage, and that in such cases the dredge would better become a "water wagon" and take as many loads as possible of water to the dumping grounds, in spite of the humorous criticisms of those who assert that we spend the government's money dredging water, and reporting it as solids.

Figure 1 shows graphically, for varying number of loads per day, the total yardage which would be obtained under conditions as outlined for Cleveland dredging, with varying percentages of suspended solids. The importance of taking this suspended matter into account, when considering the total quantity of material carried, is strikingly illustrated by this diagram.

A more general solution of the problem is now to be considered. If V = Volume of bins in cubic yards, S = Cubic yards of settled material per minute of dredging time, R = ratio of suspended solids to volume of muddy water, Rc = critical ratio at which total yardage is constant, and T = Time in minutes consumed by one trip to the dumping grounds, then

$$Rc = \frac{ST}{V + ST}$$

The quantity ST is the cubic yards of settled material which might have been obtained in the bins by dredging for T minutes, or, expressed otherwise, the amount of settled material lost by taking time off for one trip to the dumping grounds. The denominator, V plus ST, is the increase in volume of water carried, caused by increasing the number of loads by one. It is evident that Rc (V plus ST) must equal ST, in order that the increase in suspended material may equal the loss in settled material and the total remain constant. The product of S and T, together with the capacity of the bins, V, determine this critical ratio Rc. The time required for one trip to the dump grounds and the rate of settlement in the bins per minute of dredging time are each of equal importance. If one is doubled and the other halved, the result is the same. Figure 2 shows graphically the critical value Rc, expressed in percentages, for varying values of the product ST and the quantity V.

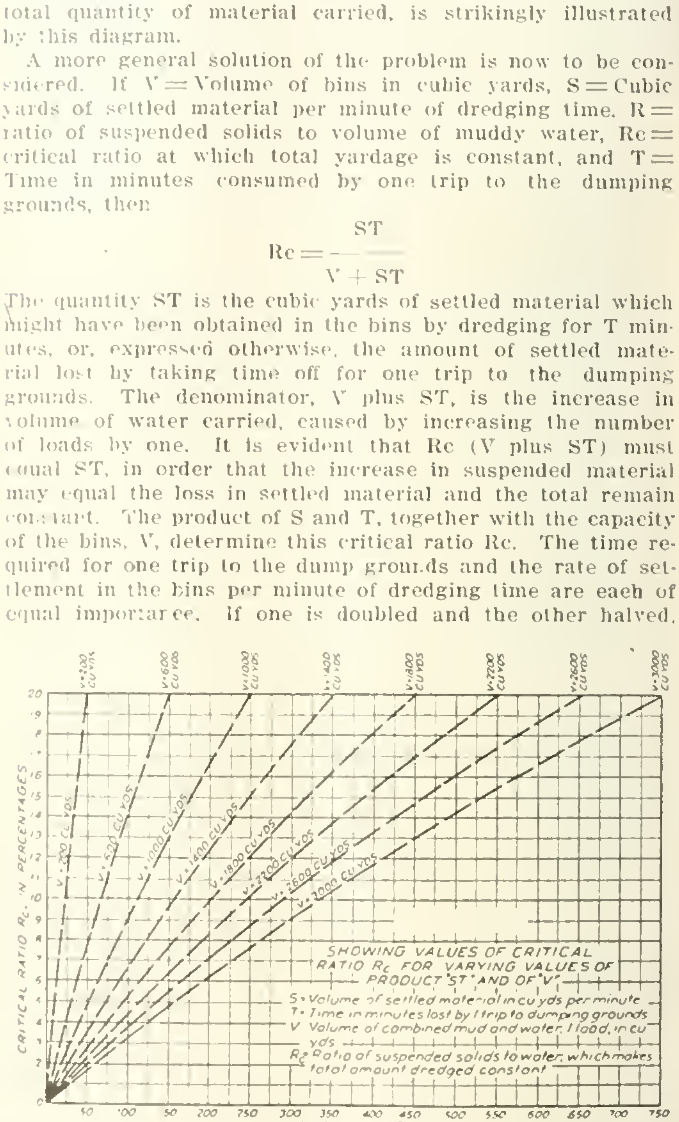


Fig. 2—Values of Critical Ratio for Varying Values of Products "ST" and "V."

The foregoing is all predicated upon a constant rate of settlement in the bins, per minute of dredging time, and no credit or amount taken for agitated material not carried to the dumping grounds. The general principle holds true even though these conditions do not obtain. If the quantity S is a variable for different stages of loading, and decreases as loading progresses, T a known constant and R determined for the class of material being dredged, the loading might economically be stopped at that stage where the product ST would give a value for the critical ratio Rc as low or lower than R. If the material agitated but not retained in the bins is of value, due to currents which may carry part of it away, the increased volume of suspended solids must balance not only the loss in settled material but also the loss in agitated material, in order to justify reduction of total dredging time by more frequent trips to the dumping grounds. If A represents the estimated valuable portion of the agitated material not retained, expressed in yards per minute, then

$$Re = \frac{T(S + A)}{V + ST}$$

The numerator is the amount of both settled and agitated material "lost" by one trip to the dumping grounds. The denominator, as in the first case, is the increased volume of water carried by increasing number of loads per day by one. It is very probable that any reasonable value assigned to A, would so increase Re as to be above any probable value of R, and would show that in this case economy lies in large loads and reducing the time lost by trips to the dumping grounds to a minimum.

It is assumed that capacity loads of settled material and water are taken out on every trip. Since the bin gates are not water tight, this involves the deposit of sufficient settled material to seal the gates. The quantity V is the total volume of mud and water actually carried away.

No account is taken in the foregoing discussion of other factors which might enter into the problem, such as relative consumption of coal while dredging as compared with that while running to and from the dump grounds, difficulty in disposing of the entire load of muddy water, changes in amount of time lost from causes other than going to dump grounds, difficulty in closing bin gates frequently, etc. It is believed, however, that a theoretical analysis of a given case will indicate at least in which direction the greater efficiency may be obtained.

Machine for Hole Digging and Pole Setting

Mr. P. O. Reyneau, Assistant Electrical Engineer of the Detroit Edison Co., writing in the Electrical World, describes a machine in use by his company with which 928 poles were set at a total cost of $4.72 per pole. To quote Mr. Reyneau: The poles set were mostly 40-ft. poles, with some "forty-fives" and a few "fifties." The costs include digging the hole, setting the pole, straightening and tamping and moving the machine between pole locations, 176 ft., as well as 20 per cent depreciation. The costs cover only working days, no charges being made on days when repairs were necessary or for moving from one place to another. The cost of $4.72 per pole compares favorably with the average cost of $6.25 for digging and setting by hand.

The gang doing the work consisted of one foreman, one digger driver, one digger operator, three or four ground men, one truck and truck driver. The machine set the 928 poles on five different jobs from March to June under very bad road conditions, mostly on unimproved clay roads, as well as on several miles of private right-of-way on farm lands, necessitating the crossing of ditches. Several of the holes were dug in more than 2 ft. of water, and quicksand was encountered in several places. It is interesting to note that the machine operates very satisfactorily in quicksand as it gets the pole in place before the sand has a chance to drift into the hole.

This machine is made by the International Earth Boring Machine Co. and is equipped with a Monarch tractor. Two sizes of drills were used, one 24-in. and one 30-in., according to the size of pole to be set. The crossarms, braces and insulators, including large pin-type insulators, can be placed on the pole before it is picked up by the machine.

Railway Location by Air Plane.—According to a recent "news letter" of the Air Service, United States Army, locating a railroad by aeroplane has been carried out by the Third Aero Squadron, Camp Stotsenburg, Philippine Islands, and one long flight has enabled a railroad engineer to determine which one of three general routes will be used for the new road. It is stated that many months and thousands of dollars have been saved in the work. Instead of three parties of locating engineers being sent out to make the survey, only one will now be necessary.

The B. & O. System of Standardizing Maintenance of Way Work

Labor is the largest single item of railway maintenance of way and structure expense; practically it is more than all the other items combined. It is, therefore, well worth while to give this item close scrutiny and careful study, the scrutiny to detect wastes, misdirected effort and faulty methods, the study to develop some system of standard methods of doing work, and of planning and dispatching to properly direct the application of those methods. Such a system has been developed on the Baltimore & Ohio R. R. It was in operation over a period of 7 years, but has been discontinued for the time being, owing to certain conditions over which the railroad had no control, which developed about the middle of 1918. From a modest beginning on the Philadelphia Division in the spring of 1911, on Jan. 1, 1918, the system was in effect over the entire main line covering about 2,000 miles of road. An interesting account of the system was given by Mr. Earl Stimson, Chief Engineer of Maintenance, in an address presented Sept. 23 before the St. Louis Railway Club. An abstract of the address follows:

In the beginning the principle of scientific management, as outlined by various authors and experts on shop practice, were used in the formation of a system which would be applicable to maintenance of way track work. It was seen that several main features must be developed to secure the expected benefits:

1. A method of equitably distributing the available force.
2. Standard methods and time for each item of maintenance work.
3. Instructions to foremen to enable them to submit accurate reports of performance.
4. Closer supervision by means of planning and dispatching the work in advance.
5. Simple forms for the notation of records and performance and for comparison of results.
6. A reward in the form of a bonus or premium as an incentive to the worker to increase his output.

How Equitable Division of Track Gangs Was Made.—One of the many features contributing to uniform maintenance conditions is an equitable distribution of the available force to the various sections. This is arrived at by accurately computing the equivalent mileage of each section, and from a monthly inspection of the section to determine the condition per cent of the principal items of maintenance work. From this percentage and the equivalent mileage the equated mileage is computed for each section, and this is used as the basis to determine the number of men required. For this purpose two forms are used.

1. Record of Track and Roadbed Features.
2. Track Condition Sheet.

The track and roadbed feature sheet shows the track mileage, main and side, the number of switches, railroad crossings, highway crossings, track pans, ditches, tunnels and other such features. In connection therewith the relative value assigned to these various features are shown. These relative values have been determined from records of expenditures on these features for a period of years. These relative values for one division thus determined are given as follows:

One mile of first main track equivalent to—
1.15 miles of second main track.
1.33 miles of third or fourth main track.
2.00 miles of branch line track.
2.00 miles of passing and thoroughfare track.
3.33 miles of yard tracks.
12 main side switches.
20 side track switches.
10 railroad crossings.
12 city street crossings.
25 to 50 county road crossings.
½ mile track pans.
4 miles ditches.

Apply the relative values to the various features on the section and the equivalent mileage of the section is obtained.

The track condition sheet is prepared monthly and is based on a careful inspection of the road, the condition per cent being the estimate of the existing condition as compared with the Standard of Maintenance set for that particular section.

In order to arrive at a more accurate result than would be obtained by an estimate of the general condition of the entire section, six classifications of the general maintenance work have been made, and each given a relative value based on the expenditures of the work [illegible] of these classifications taken from the records [illegible] years and so modified as to meet the renewal [illegible] other seasonal work. A set of relative values as determined are:

[illegible]	5
[illegible]	[illegible]
[illegible]	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
	100

Both these relative values and [illegible] for the track features are for the Philadelphia Division, which is taken as an example. These values will vary somewhat for the different divisions.

An estimate is made of the condition per cent of each of these items on each section, and this multiplied by the relative value for the item gives the calculated per cent for that item, and the total calculated per cent of all items gives the condition per cent of the section. The equivalent mileage divided into the condition per cent gives the equated mileage for the section. The ratio of the equated mileage of the section to the total equated mileage of the division determines the number of men to be allotted to that section out of the total number of men allotted the division.

Establishment of Standard Schedules. Standard Schedules, or units of performance, are established with great care, as it is essential that they be correct and that the organization of the gang and method of doing the work is the best that can be worked out.

The standard performance, or 100 per cent efficiency, is the output of a first-class gang working at a speed which can be continuously maintained without physical harm to the men, following an approved method of doing the work and consisting of the most effective number of men for the kind of work to be done.

To arrive at the 100 per cent standard, first-class gangs are selected and detail time studies made of the performance, the time studies being divided into as many moves and as much detail as possible in order that the various studies may be compared in detail and a standard method worked out which will eliminate all unnecessary moves. If it appears that an improvement can be made, the organization of the gang and the method of doing the work is altered and new studies made. When the most satisfactory organization and method has been found, a final detail study is made of the performance of the gang and this is established as 100 per cent efficiency and issued as a standard schedule.

In this way schedules have been established for all of the more important items of maintenance work.

It was first thought that, owing to the wide variation in conditions, there would be a number of items of work for which it would be impossible to work out standard schedules, but the study of performances have developed a remarkable uniformity in the output of gangs working under apparently widely varying conditions, and there are relatively few items of maintenance work which cannot be standardized. In cases where one standard schedule cannot be made to apply, as, for example, in ditching, a schedule is made for the individual job and is based either on previous records, performances under similar conditions, or observations after the work is started. For individual pieces of work of this kind the supervisor, after careful consideration and planning of a method to be followed, establishes a schedule or standard of output for 100 per cent efficiency, and the foremen's reports are graded on this basis.

Going to and from work and clearing the track for passing trains represents considerable lost time which is beyond the control of the foreman and men. This lost time is classed as detention, and studies made to determine the amount of detention show that road sections average about 10 per cent. Therefore, in grading the foreman's reports for comparison with the standard schedule, a credit of 10 per cent is allowed for detention. On terminal and yard sections the detention is usually much more; in some cases 25 per cent. Sections of this character are treated individually and a study of the detention on each section made.

Example of Standard Method and Schedule. As an example of a standard method and schedule, that of renewing ties—track not raised is given.

Method of Renewal—Track Not Raised. Men work in pairs, each starting at the end of a crib and digging ballast out of the cribs adjacent to the ties to be renewed. The spikes are then drawn and the old tie is worked into the open crib and pulled out of the track. A new bed is prepared and the new tie is slipped into place with tie tongs. One man then bars this tie close up to rail by means of a bar, and the other spikes; then they thoroughly tamp both sides to the end of the outside of the rail and 18 in. inside. The ballast is cleaned and returned to the cribs, dressing the shoulder.

Not less than two weeks after renewal the ties should be thoroughly retamped.

In pulling the new tie into place, the practice of striking picks into the face of the tie and so working it into place must not be allowed. The tongs are provided for this purpose.

TIES TIME DISTRIBUTION OF RENEWALS—TRACK NOT RAISED.

	Stone ballast. Minutes.	Gravel ballast. Minutes.	Cinder ballast. Minutes.
Cribbing out	18	10	10
Drawing spikes	3	3	3
Removing old tie	2	2	2
Preparing new bed	3	3	3
Carrying tie 100 ft.	2	2	2
Placing new tie	2	2	2
Spiking to gage	4	4	4
Tamping	13	8	8
Cleaning ballast and redressing cribs and shoulder (very dirty)	20	3	3
Carrying old tie 50 ft. and piling for burning	2	2	2
Foreman	6	4	4
Total minutes for one tie	75	43	13
Rate, ties per 10 hours	8	14	14

If any of the above items are not performed, subtract corresponding time, with an allowance for supervision, from totals and figure rate per 10 hours.

The detail time distribution is essential for correctly grading the foreman's daily reports. If all of the details of work shown are performed, then the unit performance for 100 per cent efficiency for the renewals in stone ballast is 8 ties per 10 hours. If, however, some of the items are omitted, as is the case when a gang cleaning ballast immediately follows the tie renewal gang, then the work of cleaning ballast, filling the cribs and dressing the shoulder is performed by the following gang, in which case the tie schedule is corrected by omitting this item, which makes the unit rate 11 ties per 10 hours instead of 8 ties per 10 hours.

It will be noted that the new tie may be carried 100 ft. and the old tie 50 ft. If ties are moved more than this distance, they must be trucked, in which case the foreman makes a separate distribution of the time so consumed, charging it to "trucking," which is covered by another schedule.

Instructions to Foremen. To form an accurate comparison of the performance of the various gangs, uniformity in the reports submitted by the foremen is necessary. Owing to the difficulty some foremen have in making reports, it is desirable to have all forms used by them as simple as possible. It has been found that the form of daily time report which the foreman makes to the division accountant, was well-suited for the report required in this connection, so no alteration in forms was necessary and no additional reports were required of the foreman.

It is, however, necessary that the distribution shown on the daily time report be made with care, so that each item of work can be correctly graded. To secure this result detail instructions governing the distribution and reporting of the time charges are issued.

Here is an example of these instructions, the one governing the reporting of the time charges to renewing cross ties:

Kind of work—Renewing Cross Ties (Acc't 220-b).

Manner of Reporting—State number of ties; main or side track; with or without tie plates; kind of ballast. If trucking show number of ties and distance trucked.

Items to Be Included in Time Charged.—Carrying new tie less than 100 ft., cribbing out, removing plates, removing old tie, placing new tie, replacing plates, tamping, cleaning ballast and refilling cribs, dressing ballast, carrying and piling old tie for burning, if less than 50 ft. If new tie is moved more than 100 ft., or old tie is moved more than 50 ft., separate time consumed loading, unloading and trucking.

Planning and Dispatching System.—To outline the order of the work and to assign it to the gangs to follow in sequence, so as to reduce the loss of time consumed by unnecessary movement of the gangs from place to place, a system of planning and dispatching is used.

Early in the year the program of work for the season is decided upon and charted, the proposed work being shown in yellow. Thereafter, as the work progresses, monthly sheets are prepared; the completed work is shown in green and the monthly program in red. A few days before the close of the month the division engineer calls a meeting of the supervisors for the purpose of planning the work for the month. The work to be done, the location and the relative order in which it is to be undertaken is decided upon and shown in red on the chart. The quantity of work to be accomplished is computed from the standard schedules and the force allotted for the month. The direction in which the work is to progress, the date on which it is to be commenced and the calculated date of completion are shown on the chart.

The chart is prepared in duplicate, one copy to be retained by the division engineer and the other for the use of the supervisor. Upon his return to headquarters the supervisor transmits the program to the foreman by means of work orders, giving him the program for the entire month, or any part of it, as he may see fit. For this purpose a work order, or dispatch book is provided. The book is bound in stiff back, note-book form, and contains 100 perforated leaves.

The work order is made out in duplicate, the carbon copy being filed on the dispatch board, serving as a ready reference showing the work being done by each gang and where working. The work order states the kind, location, amount of work to be done and the time to be consumed. Upon completion of the work the foreman dates and signs the order and returns the same to the supervisor. The foreman is given a work order for all work to be done. This, however, does not relieve him from the responsibility of making unforeseen and emergency repairs.

Forms and Reports.—For the purpose of recording the performance of the gangs two forms are used—one a daily record of track work performance, the other a monthly record of track work efficiency.

The result of each day's work, as sent in by each foreman on the daily time report, is posted on the daily record sheet, and the efficiency per cent of the day is computed. For example: A gang consisting of a foreman and nine men, working 10 hours per day, hold a work order to renew ties without raising track. The schedule under which the work will be done is that given as an example of a standard schedule—or 8 ties per 10 hours. The foreman's daily report shows that his gang renewed 64 ties in 100 hours. The standard time required to renew 64 ties in stone ballast track not raised, is 80 hours, whereas the actual time consumed was 100 hours. However, 10 per cent of this was consumed by clearing passing trains and other delays chargeable to "Detention," leaving 90 hours actually devoted to effective work. On the daily record sheet, under the heading of renewing cross ties, 80 is recorded as "Standard Time" and 90 as "Actual Time," indicating an efficiency of 89 per cent. All other work is recorded in the same way.

At the close of the month the "Monthly Record of Track Work Efficiency" is compiled from the totals of the "Daily Record." The monthly record shows the percentage of efficiency made by every gang on each class of work, the average of every gang on all work and the average for the supervisor's subdivision—in other words, a detailed and an accurate record of the actual performance of every gang as compared with the standard performance. The "Standard" divided by the "Actual" gives the efficiency per cent.

The Bonus Feature of System.—The system is now built up to the point where it seems complete. It provides for the proper distribution of the force, standard of methods and standards of performance and methods of comparing the actual with the standard performance, and thus determines whether or not a good day's work has been done.

So far, so good. Much is accomplished by means of the standard gang organization and methods of doing the work; much lost motion is caught up, duplication of work is avoided, and better control is had in the direction and supervision of the work. An appreciable increase in the output of the gangs will be noted, which is due more to better management than to any increase of individual effort.

To get further results an appeal must now be made to the individual for an increase in effort. This appeal was first made in the form of a published rating of the foremen and gangs according to the per cent efficiency attained, which, for a time, incited a spirit of competition, the natural desire to excel of which no man is entirely without. But effort based on this alone is not long sustained. It was found necessary that the appeal be backed with some material reward.

This reward was offered in the form of a bonus or premium. When reading the autobiography of Theodore Roosevelt, in the chapter headed "Social and Industrial Justice," I noted this line: "There should be an increased wage for the worker of increased productiveness." This is just what is provided for by the bonus system. The increased wage is paid by means of the bonus in proportion to the worker's "increased productiveness" above the established standard.

From a number of bonus systems, or methods of determining and applying bonus payments, we selected what is known as the "Emerson Bonus System." The system guarantees the daily or hourly rate, paying a bonus varying with the efficiency attained. The bonus payments start at 67 per cent efficiency, instead of 100 per cent, the standard, so as to stimulate effort to reach the standard, while a large bonus is paid for attainment above the standard. The bonus starts with small payments at 67 per cent, increasing in a curved line to a bonus of 20 per cent of the wages for the actual time worked at 100 per cent, the standard. Above 100 per cent the bonus consists not only of the 20 per cent of the wages for the actual time worked, but in addition wages for all time saved. On this basis the bonus paid for work above the standard or 100 per cent, increases 1 per cent for every 1 per cent increase in efficiency, and for 110 per cent efficiency is 30 per cent; for 120 per cent efficiency it is 40 per cent; for 130 per cent efficiency it is 50 per cent of the money earned.

Owing to the nature of maintenance of way track work it is necessary to consider the gang as a unit rather than the individual. Therefore the foreman and each man in the gang receives the bonus based on the efficiency of the entire gang.

The supervisor's bonus is determined by a formula of which both the efficiency per cent of his subdivision and the per cent of work scheduled are factors. His interest is thus enlisted and the additional work imposed upon him is paid for in proportion to its amount.

Benefits Resulting from the System.—It might here be stated that the supervisors were not required to handle the details of the operation of this system, which it was manifestly impossible for them to do in addition to their regular duties. Each supervisor was given an assistant, who devoted his entire time to the study of standard schedules and methods, to the recording and study of performances, to the instruction of the foremen in regard to standard practice, to checking in the field the reports of work done to guard against error and to acting as bonus inspector. The assistant supervisors were selected mostly from the transitmen on the engineering corps, and were young men of technical education. In some instances, however, foremen and timekeepers were selected for the position.

By no means the least of the benefits derived from this system is that of the development of the young engineer from an inexperienced transitman or draftsman, out of the engineer's office, into a well qualified candidate for the position of supervisor or assistant division engineer from which position he may later qualify for that of division engineer.

The question, no doubt, is in your minds as to the practical application of this system and as to the results obtained. In answer I give the record of a main line division some 280 miles long, where uniform maintenance conditions prevail and where the track force is largely native and the turn-over small. I give this record for the month of October for the years 1914, 1915, 1916 and 1917. The system was put in operation on the division in the summer of 1911 and was well under way by October.

	1914 Per cent.	1915 Per cent.	1916 Per cent.	1917 Per cent
Subdivision No. 1	74	78	80	94
Subdivision No. 2	74	80	80	91
Subdivision No. 3	74	82	88	91
Subdivision No. 4	72	74	91	101
Total Division	73	78	85	94

It will be noted that during the first year the percentages were quite low, close to the 67 per cent minimum of the bonus table. There was an improvement each year, until the fourth year shows a minimum increase of 17 per cent and a maximum of 30 per cent for supervisors' subdivisions and an increase of 21 per cent for the division.

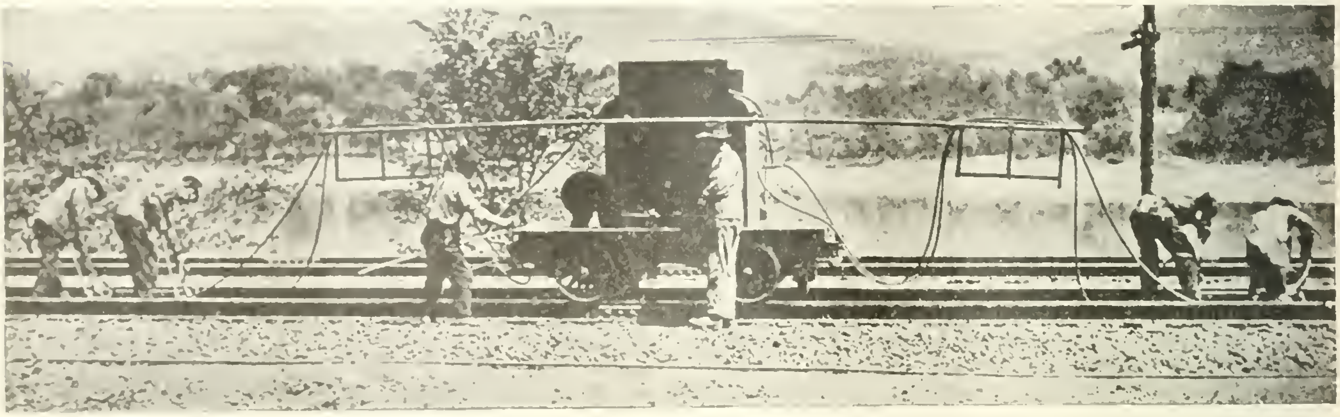
Individual gangs show quite remarkable performances, particularly during the renewal season. In June, 1917, one gang on subdivision No. 4 of this division attained an efficiency per cent of 125, earning for the foreman and each man on the gang a bonus of 45 per cent of his earnings for the month. A number of other gangs exceeded the 100 per cent standard. The average for the division that month was 94 per cent.

A study of the records of percentages shows considerable spread between the high and low gangs. This is more noticeable when comparing the gangs on a division as a whole, than when comparing those on one supervisor's subdivision. This indicates that the supervisor is all important to the successful operation of the system. That this system was continued for seven years on the Baltimore & Ohio R. R. and that it was adapted and put in operation on another large eastern railroad is evidence in itself of its practicability of application and of its productivity of results.

Labor Economy in Rail Bonding

The Lehigh Valley R. R. has developed an efficient method of rail bonding requiring less men and increasing the output. The following description and illustration are taken from the Railway Maintenance Engineer.

Two arrangements have been developed, one on the Wyoming Division and the other on the Seneca Division, which are similar in their general plan but which differ in their methods of operation. In general they consist of an air tamping machine to which four pneumatic drilling or bonding machines are attached by lengths of pipe and air hose. In one case the machine was moved by hand and in the other two motor cars were used.



Rail Bonding Outfit in Service on the Lehigh Valley R. R.

The smaller outfit was built up by fastening a 21-ft. length of $1\frac{1}{4}$-in. pipe to the side of the air compressor and parallel to the track in such a way that it cleared the top of the rail by about $5\frac{1}{2}$ or 6 ft. A reinforced U-shaped bracket with hooks made from scrap iron was fastened to each end of this pipe as a support for the air hose, upon which the air drills could be hung when not in use, or when moving from one location to another. A two-way connection was attached to the outlet pipe of the tamper to which there was attached a second two-way connection and a short length of air hose. This section of air hose was carried over the top of the tamper and a third two-way connection made fast to it. A 25-ft. length of hose and an air drilling machine were then connected with each of the four outlets so formed. This gave two machines on each side of the air compressors, each machine drilling one side of a joint and the four machines drilling the bond holes for two rail joints at a time.

The second arrangement consisted of an air compressor of a similar nature and two motor cars, connected together (with the compressor in the center) by means of two 20-ft. lengths of 2-in. pipe. Four drilling machines were used as in the preceding case, arranged so that there was but one machine to a joint.

With the completion of the drilling at each of the four joints, the air drills are suspended on hooks provided for that purpose and the outfit moved ahead under its own power. In this case the men do little or no walking and the movement from one set up to another is accomplished in about 20 seconds. The motor cars are utilized to carry such additional equipment as is necessary, such as extra drilling machines, air lines, drills, bonding wire, etc.

The results obtained by the two outfits show that the number of men usually required for the work was considerably reduced, the bonding kept up with the rail laying and the men were kept interested in their work. With the self propelling arrangement a total of 10 men were used, 4 for drilling, 2 for bonding, 1 to look after "bootleg" wires and 1 to operate the two motor cars and the compressor. This is against a total of 19 men required under the old method. A total of 730 moles of $\frac{3}{8}$-in. diameter were drilled by the smaller unit in 3 hours 36 minutes, and a total of 1,672 by the larger unit in a working time of 7 hours 30 minutes. In both cases the results were not indicative of the amount of work which could be done with these outfits in a given time, as both were delayed considerably by the rail layers.

At one point, 354 lengths of 136-lb. rail were unloaded, laid and the old 100-lb. rail picked up in a total elapsed time of 6 hours, the bonding being completed 16 minutes after the track was connected. The drill replacement record in this case was exceptional, for only six drills were replaced in drilling 730 holes at the rate of 203 holes per hour.

Working Test of Electric Shovel

The Electrical World quotes the following figures on a trial of an electric shovel by the Hydro-Electric Power Commission of Ontario in digging the Queenstown-Chippewa power canal. The shovel was of Bucyrus make, of 300 tons weight, with a 90-ft. boom, and uses buckets with a capacity of 5, 6 or 8 cu. yd. The cycle of operation is from 42 to 50 seconds. The test covered a period of seven days, and this shovel was working 90 ft. below the surface and loading material on cars about 50 ft. above its own base.

TEST ON ELECTRIC SHOVEL DIGGING 90-FT. CANAL.

Total yards, whole test	24,706.5
Total yards, day work only	15,380.0
Total yards, day and night	9,326.5
Kilowatt-hours, whole test	20,436.0
Kilowatt-hours, day work only	12,216.0
Kilowatt-hours, day and night	8,220.0
Kw.-hr. per yard, whole test	0.826
Kw.-hr. per yard, day work only	0.794
Kw. hr. per yard, day and night	0.882

Wood Preservation and Preservatives in 1919.—According to the 1920 Proceedings of the American Wood Preservers' Association, in 1919 there were altogether 108 treating plants actively engaged in the preservative treatment of wood in the United States. There were 15 idle plants and 3 abandoned ones, making a total of 126 in all. During that year 37,567,927 cross ties were treated or 6,959,451 more than were reported in 1918. These figures are based on full reports from 98 of the active plants and estimates were made for the remaining 10 plants not reporting. For all purposes of wood preservation, including cross ties, the consumption of creosote oil in the United States in 1919 was 12,779,861 gal. in excess of the 1918 use. The importation of foreign oil rose from 1,545,217 gal. in 1918 to 11,268,379 gal. in 1919. The consumption of zinc chloride in 1919 was 43,483,134 lb., the largest quantity ever before used in any previous year and 12,382,023 lb. over the 1918 consumption.

How to Cut Wire Rope.—A practicable way of cutting wire rope is described as follows in Leschen's Hercules: First, securely bind the rope on each side of the place to be cut; place the cable over a length of old railroad rail or a piece of steel; then cut by means of a coal cutting chisel with handle and a sledge hammer. If it is necessary to cut ropes frequently it is advisable to secure a special cutter for the purpose.

Rental Schedule for Estimating Construction Equipment Expense

A schedule, evolved from the records and experience of contractors, manufacturers and rebuilders of equipment and designed to furnish contractors with a practical means for estimating equipment expense and determining adequate rental charges has been approved by the Executive Board of the Associated General Contractors. The schedule which was prepared by the Research Division under the direction of the Committee on Methods of the Association is printed in the November Bulletin of the Associated General Contractors. The schedule and discussion of its application follow.

To use the schedule with safety, it is essential to understand how the amounts were obtained, how they are to be applied, and how they are limited in determining rental charges. Knowing these things, no great difficulty should be found in establishing the charges within the bounds of practical accuracy.

For the reason that arithmetical averages as obtained from available records, gave few rational values for depreciation and repairs such averages were given less weight in establishing the tabular amounts than the practical experience of contractors. In fact, the strongest evidence that these amounts are reasonably safe and accurate lies in the endorsement given them by experienced general contractors.

A tentative draft of the schedule was submitted to members in the Weekly Bulletin of July 31. They were asked to criticise the amounts and offer suggestions. In accordance with the criticism received, which evinced considerable study upon the subject, some of the tabular amounts were changed. As it now stands, the schedule represents the consensus of opinion of many contractors, and with the proper understanding of what the percentage amounts mean, it should offer a safe means of estimating rental charges.

What the Values Mean.—The endless variation of job conditions, such as topography, ground formation and climate, indicate how great may be the error of any fixed equipment charge when applied to the exceptional job. But having figures which represent the mean of many projects, a starting point exists for ascertaining reasonable charges for the exceptional circumstances. Figures given in the standard schedule may be said to show equipment expense when machines are not required to operate continuously under either the worst or the best of operation strain. When no especially favorable or unfavorable circumstances attend a project, the tabular values probably give the expense within a permissible error.

To eliminate error as far as possible by permitting consideration and comparison of the individual items that make up equipment expense, the gross amounts are reduced to their component parts. Thus any item of the expense which is known to be unusually high in specific cases may be adjusted in the schedule to obtain a more appropriate rental rate.

Components of Expense.—Seven items of equipment expense constitute the total rental charge and require consideration in estimating a lump sum contract or in determining fixed rate rentals. An average value for each of these items which represents the expense of a general contractor's outfit as a whole, has been approved by the Executive Board. The items referred to and their annual proportions of the equipment's initial cost are as follows:

Schedule of Typical Rental Charge.—Items of expense are expressed as per cents of original capital investment for equipment having a useful life of 6 years and a salvage value of 25 per cent of the original cost.

	Per cent
1. Average depreciation	12½
2. Equivalent annual interest at 6½ per cent	4
3. Shop repairs	6
4. Field repairs	4
5. Storage and incidental	3½
6. Insurance	1
7. Taxes	1
Total annual expense	32
Equivalent expense on basis of 8 months' working time per year	48
Rental rate per month	4

How to Obtain Proper Percentage.—These percentages and those given in the detailed schedule were determined according to the following principles:

The economical life of a machine is considered to end when its value has depreciated to 25 per cent of the original cost. The average annual depreciation then amounts to 75 per cent of the initial cost divided by the number of years it may be expected to give service. The initial cost of a machine is represented by the cost of the equipment delivered at the contractor's yard.

Interest should naturally be charged at the prevailing rate. This may be computed in three ways.

1. By charging the prevailing rate each year on the depreciated value of the machine.

2. By charging the prevailing rate each year on the average value of the machine during economical life. For example, when the salvage rate amounts to 25 per cent the average value equals (100 per cent + 25 per cent) divided by 2 = 62½ per cent.

3. By finding the proportion which the average value is of the initial cost and charging this proportion of the prevail

RENTAL SCHEDULE FOR CONSTRUCTION EQUIPMENT

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Yrs							
[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]
[illegible]	4	18¾	[illegible]	[illegible]	[illegible]	1	1	[illegible]
[illegible]	8	[illegible]	[illegible]	4	[illegible]	1	1	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1	10
[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	1	1	[illegible]
[illegible]	[illegible]	18¾	[illegible]	[illegible]	[illegible]	1	1	[illegible]
[illegible]	4	18¾	[illegible]	6	[illegible]	1	1	[illegible]
[illegible]	4	18¾	1	[illegible]	[illegible]	1	1	[illegible]
Cars, steel dump	6	[illegible]	8	4	[illegible]	1	1	[illegible]
Cars, wood dump	5	[illegible]	[illegible]	[illegible]	[illegible]	1	1	30
[illegible]	8	[illegible]	4	[illegible]	3½	1	1	[illegible]
[illegible]	5	[illegible]	8	[illegible]	3½	1	1	[illegible]
Compressor, steam	7	10¾	[illegible]	[illegible]	3½	1	1	[illegible]
Compressor, gasoline	4	18¾	6	4	3½	1	1	[illegible]
Compressor, electric	6	12½	[illegible]	[illegible]	3½	1	1	24
Concrete chutes	2	[illegible]	1[illegible]	15	3½	1	1	[illegible]
Conveyor, belt	2	37½	[illegible]	6	3½	1	1	[illegible]
Conveyor, bucket	2	37½	10	6	3½	1	1	59
Crusher, rock	6	12½	[illegible]	3	3½	1	1	26
Derrick, wood	[illegible]	17	4	1	3½	1	1	28½
Derrick, steel	10	7½	4	3	3½	1	1	20
Dragline, steam	6	12½	9	8	3½	1	1	35
Dragline, gasoline	4	18¾	10	10	3½	1	1	44¼
Dredges, electric	8	[illegible]	[illegible]	7	3½	1	1	29
Drill, tunnel carriage	5	1[illegible]	8	8	3½	1	1	[illegible]
Drill, traction well	6	12½	[illegible]	10	3½	1	1	[illegible]
Drill, tripod	4	18¾	7	10	3½	1	1	41¼
Drill, jack hammer	4	18¾	7	6	3½	1	1	37¼
Engine, gas	6	12½	8	8	3½	1	1	34
Engine, steam	10	7½	[illegible]	5	3½	1	1	23
Excavator, cableway	6	12½	4	12	3½	1	1	34
Excavator, Keystone	5	15	8	4	3½	1	1	32½
Excavator, trench	5	15	8	6	3½	1	1	34½
Forms, steel concrete	2	37½	20	20	3½	1	1	83
Graders, common road	4	18¾	12	6	3½	1	1	42¼
Graders, elevating	4	18¾	15	[illegible]	3½	1	1	46¼
Hoist, steam	10	7½	6	4	3½	1	1	23
Hoist, gasoline	6	12½	7	8	3½	1	1	33
Hoist, electric	8	9½	[illegible]	3	3½	1	1	23
Locomotives:								
Industrial steam	[illegible]	[illegible]	[illegible]	4	3½	1	1	[illegible]
Industrial gas	4	18¾	13	10	3½	1	1	47¼
Industrial battery	4	18¾	17	4	3½	1	1	[illegible]
Standard gage	10	7½	6	4	3½	1	1	23
Crane, steam	8	[illegible]	7	8	3½	1	1	30
Crane, electric	8	9½	6	4	3½	1	1	25
Mixer, steam	5	15	12	4	3½	1	1	36½
Mixer, gasoline	4	18¾	13	8	3½	1	1	45¼
Mixer, electric	6	12½	12	4	3½	1	1	34
Mixer, paving steam	5	15	[illegible]	4	3½	1	1	[illegible]
Mixer, paving gas	[illegible]	25	16	9	3½	1	1	55½
Motors	6	12½	6	4	3½	1	1	28
Pile driver, steam	8	9½	[illegible]	[illegible]	[illegible]	1	1	[illegible]
Pile driver, track	10	7½	5	3	3½	1	1	21
Pile hammer, steam	[illegible]	[illegible]	[illegible]	[illegible]	3½	1	1	[illegible]
Pipe, galvanized	3	25	[illegible]	6	3½	1	1	41½
Plows	[illegible]	25	15	1	3½	1	1	[illegible]
[illegible]	4	18¾	[illegible]	8	3½	1	1	52¼
Pump, centrifugal	[illegible]	[illegible]	6	4	3½	1	1	25
Pump, piston	6	12½	[illegible]	[illegible]	3½	1	1	30
Pump, pulsometer	8	9½	[illegible]	4	3½	1	1	21
Pump, Emerson	8	9½	[illegible]	4	3½	1	1	21
Rails	8	9½	5	[illegible]	3½	1	1	[illegible]
Rooter, [illegible]	5	15	8	4	3½	1	1	32½
Rock channeler	6	12½	[illegible]	8	3½	1	1	33
Roller, steam road	10	7½	5	[illegible]	[illegible]	1	1	21
Saw rigs	4	18¾	10	15	3½	1	1	49¼
Scraper, wheel	[illegible]	25	8	4	3½	1	1	42½
Scraper, slip	1	75	[illegible]	[illegible]	3½	1	1	115½
Scraper, fresno	2	37½	25	15	3½	1	1	83
Shovel, steam	6	12½	7	6	3½	1	1	31
Shovel, gasoline	4	18¾	9	[illegible]	3½	1	1	[illegible]
Shovel, electric	7	10¾	6	5	3½	1	1	27¼
Switches, fabricated	3	25	3	3	3½	1	1	36½
Tower, steel hoist	7	10¾	[illegible]	4	3½	1	1	23¼
Tractor, wheel gas	6	12½	9	5	3½	1	1	32
Tractor, caterpillar	5	15	15	10	3½	1	1	45½
Wagons, dump	4	18¾	17	5	3½	1	1	[illegible]
Wagons, hauling	4	18¾	12	3	3½	1	1	39¼
Wagon loaders, power	5	15	10	6	3½	1	1	36½

ing rate [illegible]. This [illegible] is [illegible] equivalent annual interest and [illegible] interest [illegible] cost [illegible] the same [illegible] pre[illegible] to the [illegible] value of the [illegible]. This is the method used [illegible] 21 per cent of the [illegible] per cent of the [illegible] 4 per cent.

Shop and field repairs are [illegible] the Committee [illegible] methods that field repairs be considered a part of [illegible] cost plus contracts and shop repairs be [illegible] contractor and covered by the fixed rate rental [illegible] recommendation [illegible] on the ground that an owner should not be made to pay the total cost for example of retubing a boiler which may have been burned out accidentally on another owner's work.

The other items of cost require no special explanation.

Three Types of Charges.—[illegible] equipment and occasion[illegible] establish rental rates as follows:

1. For a lump sum or unit price estimate.
2. To owners on cost plus work.
3. To others than client owner.

In these instances charges should be made as follows:

1. The rental charge or equipment expense for lump sum work includes all the items mentioned above.
2. The fixed rate to owners on cost plus work will include all but field repairs, if this item is paid as a cost of the work. To the amount thus determined may be added a service charge depending upon the policy of the contractor, i. e., whether the service of equipment is included in the profit fee or carried in the rental charge.
3. The charge to persons other than client owners includes all the items of expense and an additional amount for profit or payment for the machine's earning power.

A further consideration in each of these cases is the rate for double shift work, where the percentages for depreciation and repairs should be doubled, or nearly so.

Individual Judgment Essential. The committee desires to emphasize the fact that the values presented in the table should not be considered absolute in determining a rental charge. A real danger presents itself in using any tabular percentage without investigating the conditions under which the equipment is to work. To illustrate: if the values here given for a standard gage shovel outfit were applied to such an outfit engaged constantly in excavating hard rock, the probability is that the charges allowed would not cover more than half the expense. The frequent dobey shots and the dropping of heavy boulders into cars entails a higher rate of depreciation and repairs than is given in the schedule. On the other hand, if this shovel outfit were steadily engaged in digging sandy loam, the values given in the table would probably cause the equipment charge to contain a fair per cent of profit.

It is with the understanding that individual judgment and experience should adjust the tabular values to meet unusual conditions that this schedule is offered to contractors.

Individual Equipment Rental Schedule. The component expenses incurred by the ownership and maintenance of construction plant are expressed in this table as percentages of the initial cost for individual items of equipment. They indicate the probable annual expense without profit under ordinary job conditions and should be included in any lump sum estimate or in determining time rate rental charges. The salvage value in all cases is considered to be 25 per cent of the initial cost.

Total percentage amounts in the extreme right-hand column should be applied to the total cost of a machine, including charges for transportation from the factory. This gives the total annual charge which for a lump sum contract covering a full season is the total equipment expense. For determining a monthly, weekly or daily rental rate the annual amount is divided by the number of such periods in the year during which construction work may be carried on.

Short Course for Water Plant Operators. The Texas State Board of Health, Austin, Tex., in co-operation with the University of Texas will give a short course of instruction for waterworks attendants and filter plant operators. The course will be held at Austin, Tex., and will cover the week beginning Jan. 10, 1921.

N. C. & St. L. Ry. Plan for Rationing Maintenance of Way Employees

An illustration of the present-day trend in caring for railway labor in order to increase its efficiency and to reduce the turnover was given by Mr. Hunter McDonald, Chief Engineer of the Nashville, Chattanooga & St. Louis Ry., in a paper presented Oct. 27 at the annual meeting of the American Railway Bridge and Builders' Association. An abstract of the paper follows:

In 1918 the cost of boarding the men had run far beyond the amount received by the company for such board. Not wishing to raise the charge for board, a study was made in the chief engineer's office to see what economies might be effected by a system of centralized purchasing and distribution and strict rationing. The study indicated that no increase in charge for board would be necessary and that substantial savings would be effected at the then existing rates. The purchase of dining car and subsistence supplies was, therefore, assigned to the purchasing agent, and a commissary agent was appointed to look after it.

Subsequent experience fully demonstrated the accuracy of this conclusion, but later advances in food cost and cook's wages have again put the cost above the amount received.

The ration allowance was estimated largely from the past average consumption of various articles, was checked with prevailing United States army rations, and was known to be ample if proper economy and care were exercised. As a check against requisitions, the ration allowance is required to be filled in on the subsistence report form. Requisition form, subsistence report form and dairy account form are prepared by the foreman and sent to the division engineer's office.

The division engineer prepares a summary of all supplies ordered, copies each requisition and subsistence report, fills out the last two columns, and forwards three copies of each to the purchasing agent, sending a copy also to the chief engineer.

Each foreman is allowed to purchase locally dairy supplies, including fresh meat, butter, eggs and milk equal in amount to an authorized allowance per man—at present 6 ct. per day for bridge and building gangs and 15 ct. each per day for the foreman and assistant foreman, the only white men on extra gangs. These purchases are shown on the dairy account form, certified to by the foreman and forwarded with the requisition, checked by the division engineer and commissary agent, and vouchered by the purchasing agent. In emergency, other than dairy supplies can be purchased locally, and during the summer season fresh vegetables and fruit can be purchased in lieu of potatoes, canned goods, etc., allowed on the ration list. These purchases are offset by deductions from the requisition, and emergency purchases must be fully explained.

The circular inaugurating the plan described the duties of the commissary agent as follows:

1. To adopt the most economical methods of purchasing and distributing.
2. To keep in touch with the different departments, by personal investigation, to see that no waste is occasioned in handling at the point of consumption.
3. To see that cook and dining cars are kept in a sanitary condition.
4. To keep a check on all requisitions to see that they conform to the balanced ration and subsistence reports.
5. To understand that he has no authority to issue orders to employes of above departments, but is to act in an advisory capacity and, when conditions needing correction are not given prompt attention, report the facts to the purchasing agent.

The commissary agent carefully checks all requisitions and sees that they are properly balanced as to food values and in accordance with the ration allowance for the estimated number of men to be worked for the succeeding month. After the quantities to be purchased are determined, bids are solicited from reliable firms for such as are not already in stock. Complete specifications accompany all solicitations for bids. Orders are awarded to the lowest bidder on any article regardless of whether or not his bid is the lowest on all the articles.

The goods for shipment to the men are packed at the commissary in Nashville, in substantial cases and coverings which are returned promptly and used as long as they are serviceable. Invoices are sent by train mail and also packed with the goods. These are checked by the foreman and returned to the division engineer, who O.K.'s and forwards them to the commissary agent.

Perishable goods are forwarded by baggage, others by local freight. The company's telephone is used freely to keep in touch with gangs which are moved unexpectedly. Comparative statements of costs for each gang are made up in the chief engineer's office and the [illegible] are sent to all division engineers.

It is the duty of the division engineers to note all cases of apparent extravagance or dishonesty of cooks, and the commissary agent also calls attention to irregularities.

A lunch club is operated in the purchasing department, and the food for it is furnished at cost by the commissary agent. He thus makes a practical test of the quality of all food stuffs purchased, and none is sent out that is not known to be of the quality specified and in good condition. Three months after the inauguration of the plan the balance was on the company's side of the ledger.

TABLE I—COMPARATIVE STATEMENT OF MONTHLY BOARDING AVERAGES FOR BRIDGE AND TRACK GANGS

	1918			1919		
Month	Man days	Cost with cook	Food cost	Man days	Cost with cook	Food cost
		Bridge Gangs				
January	[illegible]	$0.651	[illegible]	[illegible]	$0.618	$0.419
February	[illegible]	.666	[illegible]	[illegible]	[illegible]	[illegible]
March	8,169	[illegible]	[illegible]	10,187	.622	.411
April	8,411	.72	[illegible]	[illegible]	[illegible]	[illegible]
May	[illegible]	.68	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	.648	[illegible]	[illegible]	[illegible]	[illegible]
July	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
August	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
September	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
October	[illegible]	.68	[illegible]	[illegible]	.677	[illegible]
November	10,177	[illegible]	.486	[illegible]	.592	.388
December	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.410
Total	[illegible]	*[illegible]	*[illegible]	[illegible]	*[illegible]	*[illegible]
		Track Gangs				
January	[illegible]	[illegible]	$0.417	[illegible]	$0.457	[illegible]
February	[illegible]	[illegible]	[illegible]	[illegible]	.422	.308
March	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.298
April	[illegible]	[illegible]	[illegible]	[illegible]	.470	.345
May	[illegible]	[illegible]	.401	7,481	.503	.375
June	[illegible]	[illegible]	[illegible]	[illegible]	.510	[illegible]
July	[illegible]	.481	[illegible]	[illegible]	.413	.288
August	[illegible]	[illegible]	.347	[illegible]	.512	.345
September	[illegible]	[illegible]	[illegible]	6,156	.479	.331
October	[illegible]	[illegible]	[illegible]	[illegible]	.420	.289
November	[illegible]	[illegible]	.427	[illegible]	.432	.297
December	[illegible]	.521	.381	[illegible]	.470	.307
Total	[illegible]	*[illegible]	*$0.406	[illegible]	*$0.460	*$0.432

*Average.

TABLE II—STATEMENT OF ANNUAL BOARDING COST.

	1918.	1919.
Bridge Gangs.		
Average cost with cook per man per day	$0.621	$0.618
Average food cost	.452	.40[illegible]
Man days worked	101,5[illegible]	81,120
Track Gangs.		
Average cost with cook per man per day	$0.546	$0.46[illegible]
Average food cost	.406	[illegible]
Man days worked	109,159	91,948

Bridge gang, 1918 worked 101,543 man days, loss $0.02 over 60 ct. per day	$2,1[illegible]5.45
Track gang, 1918 worked 109,159 man days, loss $0.036 over 50 ct. per day	[illegible],929.7[illegible]
Total loss	6,125.12
Bridge gang, 1919 worked 81,120 man days, loss $0.018 over 60 ct. per day	1,514.16
Track gang, 1919 worked 91,948 man days, gain $0.04 under 50 ct. per day	[illegible],677.92
Net gain	$2,163.76

TABLE III—COMPARATIVE STATEMENT OF BOARDING COST FOR FIRST 6 MONTHS.

	1919			1920		
Month	Man days.	With cook	Without.	Man days.	With cook	Without.
		Bridge and Building Gangs				
January	10,737	$0.648	$0.419	6,011	$0.615	$0.397
February	10,436	.632	.435	5,127	.651	.411
March	10,380	.622	.414	[illegible]	[illegible]	.416
April	8,450	[illegible]	.390	[illegible]	[illegible]	[illegible]
May	4,772	.598	.296	6,208	.624	.365
June	4,566	.625	.419	[illegible]	.601	[illegible]
Totals	49,241	$0.619	$0.417	[illegible]	[illegible]	[illegible]
		Track Gangs				
January	[illegible]	$0.457	$0.245	7,523	$0.455	$0.295
February	13,990	.422	.308	7,290	.485	.305
March	12,253	.416	.298	8,111	.473	.300
April	6,325	.470	.345	8,321	.494	.305
May	3,481	.503	.375	8,913	.524	.321
June	3,738	.510	.343	10,542	.475	.28[illegible]
Totals	53,784	$0.463	$0.336	50,653	$0.484	$0.301

1920 cooks' hours increase about 25 per cent; 1920 cooks' wages increase about 20 per cent.

Although the foodstuffs [illegible] the cost above the [illegible] budget and training of [illegible] has not yet reached a point where [illegible] would seem imperative. It is hoped [illegible] lower food costs, notwithstanding [illegible] cooks' wages, the balance [illegible] charged. It is the purpose [illegible] and when the receipt [illegible] are made [illegible], it is expected that the boarding [illegible].

The accompanying data [illegible] track and bridge gangs [illegible] six months and in the aggregate [illegible] cases. Table III shows comparative [illegible] the first six months of the years 1919 and 1920.

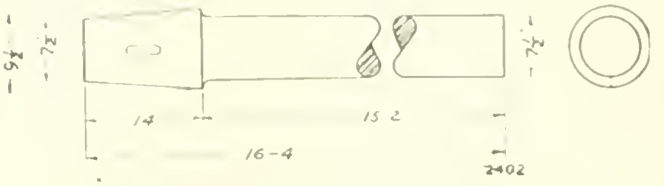
This plan of feeding [illegible] has many advantages. The men are [illegible] are generally [illegible]. With proper food [illegible] quality of the labor will greatly improve. In case of wrecks or washouts, complete outfits are at hand to feed [illegible] men and other additional forces who have to be quickly assembled.

The meals are furnished promptly, are well cooked and served, which is not always the case where the messing system is adopted. The cost is much less to the men than they could obtain by any other method. There is no profiteering on the men such as may often be the case where they are boarded by contractors or by the foremen. The computed cost for board includes the cooks' wages. In many cases on other railroads, the cook is furnished at the expense of the railroad where a gang consists of six or more men. Men who are entitled to have their expenses paid while traveling are often fed at the boarding cars at a [illegible] actual saving.

Repairing Cutter Shaft of Suction Dredge by Welding

The accompanying sketch shows a cutter shaft of a large suction dredge welded by the thermit process by C. B. Greene, Atlantic Coast Line R. R., Savannah, Ga. The shaft is 7½ in. diameter, 16 ft. 4 in. long with a head 9½ in. which fits in a square socket in the cutter wheel.

The old shaft was broken and the head completely worn out, so a piece of material of the proper length was obtained and a new head welded on. A wooden pattern was made ¼ in. larger than the finished size of the job. A mold of fire clay and core sand was made from this pattern in two halves. The mold was then baked hard in the core oven.



Sketch of Cutter Shaft Welded.

When it had dried hard the new end was fitted to the shaft, lined up perfectly and both parts clamped all together good and tight. The shaft extended clear through the mold to within 1 in. of the end. That gave a solid mold and it was not necessary to use so much thermit. The clamps were then taken off, the shaft removed and heated to a good white heat in a forge.

As everything was all set, lined up in place and the crucible charged and hanging in position, it was only necessary to lower the shaft in place, superpose the upper half of the mold, clamp it on tight, lute around with fire clay and ignite the 125 lb. of thermit. A perfect weld was obtained. After machining the weld the shaft was restored to operation and according to latest reports was holding up. Not including baking the mold, only 6 hours were required for the job.

Associated General Contractors to Meet in New Orleans.—The annual meeting of the Associated General Contractors will be held Jan. 25-27 at New Orleans. A three days' convention will be held, consisting of three general business sessions and two sessions devoted to meetings of the highways, buildings, public works and railroad divisions of the association. George H. Glover, 1020 Whitney Bldg., New Orleans, La., is chairman of the convention committee.

The Rail Shortage

As a contribution to the d[illegible] rails so sorely needed by the railroads in [illegible] facilities and equipment in order to catch up [illegible] with the business of the country the following [illegible] rail situation are quoted from a paper by C. W. [illegible] W. Hunt and Co., Chicago, read before the Rail[illegible] of the Western Society of Engineers.

Some time ago I estimated that there was a shortage of 10,000,000 tons of rails in the United States as of Jan. 1, 1917. This figure was reached by taking [illegible] the annual consumption of rails for 24 years and the increased mileage of the roads reporting to the Interstate Commerce Commission for the same period. The shortage referred to could be defined as the amount of rail of new section necessary to put the roads in a prime physical condition typical of good practice necessary for handling the heavy equipment and traffic desired. No particular reason has developed for modifying the calculated shortage of 10,000,000 tons then existing, but the three years of government control requires that an addition of 2,000,000 tons be made to it, so that 12,000,000 tons really represents the actual shortage today.

This large deficiency may seem unreasonable, but a moment's reflection and the fact that it implies bringing the roads to a prime condition, will perhaps show its consistency. In this connection, it is surprising to note the large amount of light-section rails existing on important lines, where motive power and rolling stock are not only constantly increasing in weight but where traffic is becoming much heavier. For example, on ten important railroads, namely, the New Haven, Seaboard, Louisville & Nashville, Santa Fe, Rock Island, Missouri Pacific, Great Northern, Union Pacific, Northern Pacific and the Southern Pacific, there was approximately 32,500 miles of rail weighing less than 80 lbs. per yard at the beginning of 1917. No doubt, a large part of this was laid on other than main line track, the figures for such instances not being available, but four of the roads mentioned are reported as having over 10,000 miles of this light rail in places where its removal appears an early essential. Replacing this 32,500 miles with 85-lb. rail would require over 4,000,000 tons of new steel, or 30 per cent of the country's calculated shortage—and apparently even then only a few of the high spots have been touched.

The shortage can be estimated in another way, with reference principally to the general upkeep of the roads since 1914, when the great war started. For six years prior to 1914 the total consumption—meaning production plus imports and minus exports—of all rails in the United States was 16,085,000 tons, or an average per year of 2,680,000 tons. For the six years 1914 to 1919 inclusive the total consumption was 12,124,000 tons, or an average of 2,020,000 tons. Thus, the total deficiency in consumption for six years is approximately 4,000,000 tons, to which must be added probably a million tons more for the year now ending. In other words, 5,000,000 tons of rail should be provided at once to balance the rate of consumption that existed for six years prior to the war, and, needless to say, this figure takes no account of the tremendously increased volume of traffic which has worn out rails with great rapidity in the last few years.

Calculations, therefore, indicate that, as an emergency measure, 5,000,000 tons should be immediately furnished the roads, while in addition there is an apparent shortage of 7,000,000 tons more necessary to put the roads in the proper physical condition. These tonnages, representing deficiencies, must be supplied over and above the normal consumption which for a considerable period prior to the war averaged about 2,800,000 tons annually. A very conservative estimate then shows, after making allowance for rates of renewal which cannot be accurately calculated, and allowing 500,000 tons per year for export purposes, that the country's rail mills should be called on to produce at least 4,500,000 tons of rails per year for the next five years to insure a return to normal. I fear that the chances of obtaining this enormous tonnage of rails are not bright and not so very different from some of the conditions existing 75 years ago.

For many years, up to say 1906, the country's production of steel ingots and rails increased proportionately, rails then being regarded as one of the principal, if not the chief, tonnage factors of ingot production. As high as 30 per cent of the total ingot supply had been rolled into rails, and in 1906, the banner year of rail production, when 3,977,000 tons were rolled, about 18 per cent of all the ingots produced were made into rails. Ingot production has steadily and rapidly increased, and in 1917 it was practically double that of 1906. But rail production has almost as steadily and rapidly declined, and in 1917 when all ingot production records were broken the tonnage of rails rolled amounted to only 6½ per cent of the tonnage of ingots cast. In short, doubling the country's ingot production has apparently resulted in decreasing the rail capacity rather than in adding to it. This, of course, is due to the greatly increased demand for steel products of all description. In the last few years there has been a much larger tonnage of rods rolled for wire drawing than there has of rails, while at the same time the production of sheared plates has passed that of rails, and steel for pipe purposes is about equal to the production of rails. The demand for these miscellaneous products and the lessened demand for rails has resulted in some cases of forcing rails into the background to such an extent that it is doubtful that the rail mills of the country today have the actual capacity they had ten or fifteen years ago.

It must not be supposed that any rail mills have been really abandoned. The point is that the demand for other products than rails has become so great that manufacturers have increased their ingot capacity to take care of it, and in some cases found a way to take care of it by utilizing the existing rail mills to roll those products in.

It is very difficult to estimate the country's capacity for producing rails today, because of these confused conditions. Probably with sufficient insistence the 1906 record of nearly 4,000,000 tons could be reached but, as pointed out, this could only be done by decreasing production of some other products now easily contemplated. A conservative estimate of the country's ability to furnish rails without serious interference with other business gives 3,500,000 tons as the possible annual yield, and this is a million tons short of what ought to be supplied annually for the next five years. Let us hope, however, that conditions will brighten so that, as was formerly the case, the steel rail business will be considered more attractive to the mills and production be resumed on a scale necessary to meet every demand that the roads may make for tonnage and prompt delivery. Orders for 1921 rails are running fully 20 per cent larger than the orders placed by the same roads for 1920 rail, a condition which obviously indicates that railroad officials are thoroughly awake to the necessity for rehabilitating the tracks as rapidly as time and finance will permit.

The V-Bed Method of Felling Timber

A method of felling timber, which is said to not only eliminate the hazards of the "back kick" of the tree as it leaves the stump, but also results in the actual saving of timber, is used by the Edward Hines Yellow Pine Trustees in its operations in Southern states. In felling trees by this method both sawyers in the crew are provided with an ax, and one working from each side of the tree cuts a deep V-shaped notch, instead of sawing the undercut as formerly. The saw is then started from the opposite side so that it meets the upper points of the V. If the cuts have gone deep enough the falling tree breaks clean, pulling no splinters from the butt, thus saving material.

Stump Cut With V-Bed.

The V-shaped wedge remaining on the end of the log not only prevents it from "kicking back" over the end of the stump, but actually forces it to jump a distance away from the stump.

Compromise Joints in Electric Railway Track Work

A resume of the difficulties which have to be met in joining rails of different cross sections and how these difficulties have been overcome is given by Mr. R. C. Cr[illegible], Engineer Surface Roadway, Brooklyn Rapid Transit Company, in a recent issue of the Electric Railway Journal, from which the following is taken:

The joining of two rails of unlike cross-section is by no means an easy task and the difficulty in successfully doing so is increased when either one, or both of the rails is worn. The wear which adds to the trouble can take place in the head surface, in the sides or undersides of the heads and sometimes in the tops of the bases. If we add to these items the contour or sectional differences we have a problem of no mean order when we attempt to make up the joint. It is thought that, in proportion to the number of compromise joints on any one electric railway as compared with regular joints, one of the former will cause more maintenance expense than several hundred of the latter.

As a matter of fact, the joining of two rails of the same cross-section (mechanically, at least) has presented a problem which has not yet been solved to the entire satisfaction of track engineers. One of the difficulties lies in the minute differences and discrepancies in the "fishing section," which are found in what appear to be the most perfect of new rails and the angle bars or joints designed to fit them. These differences and discrepancies tend to magnify the compromise joint problem.

A compromise is an adjustment of differences by mutual concessions, and, since this is just what happens when rails of different sections are joined, the joint plates or splice bars which are used for this purpose are called "compromise" joints. These, by the way, must not be confused with "compromise" rails, to which reference will be made later. Compromise joints are sometimes called "combination joints," "taper joints," or "step" joints. Our British friends are apt to call them "joggle plates."

Compromise joints are confined mainly to special trackwork, where they are used to connect the guard rails and other special rails used in special track work with the adjacent rails in tangent or connecting tracks. Compromise joint troubles have emphasized the desirability of having guard rails "fish" with the rails used in tangent tracks and there is a marked tendency in this direction, which has been accelerated by the efforts of maintenance engineers to adopt rail standards for their system.

There are at least ten different types of compromise joints or means for accomplishing the same purpose which have been used with more or less success. The earliest forms consisted of the regular splice plates or angle bars, upset and offset in the field or in the shop by the blacksmith. With T-rails where the sectional differences were not great, such joints gave fair service provided the smith was good at retempering the bars and had fair skill at reproducing the fishing angles and fairly true surfaces. With a job of connecting a 4-in. T-rail and a 9-in. tram girder rail, however, such a joint has several objections, and is particularly difficult to make even when it takes the forms of special cast steel bars or of bars planed from flat bar steel stock. Nevertheless the old custom of making such joints by cutting and smithing deep plates prevails to a large degree. Although the arc welder and the acetylene welding and cutting torch are more and more coming into use for this purpose, there is little doubt that in many cases the skilled blacksmith will never be entirely supplanted. Mention should be made here of the machine devised by C. H. Clark for upsetting joint plates, which greatly facilitates this sort of work. This devise has had its greatest use on overhauling or rehabilitation work on old tracks, where a great number of plates of the same shape require upsetting. This work is quite similar to regular compromise joint work, since plates must be upset and sometimes offset in order to take up wears and head pounds or dishes.

Incidentally, the rail grinder has greatly aided in the work of making satisfactory repair joints of this type, by facilitating the detail of finishing the head surfaces to a true level.

Compromise Rails.—Compromise rails present another means of connecting dissimilar rail sections. They usually consist of two pieces of rail, one of each section to be joined and each having a length of from 4 to 5 ft., which are joined by some form of welding [illegible] length all of from 8 to 10 ft. (S[illegible] only 8 ft. long over all, as when made [illegible] contoured to each of the rail sectio[illegible] compromised.) Compromise rails are quite [illegible] track work where the outside pieces [illegible] rail. In some cases as in crossings [illegible] frogs may consist of compromise rails and [illegible] making connections between the T rail and [illegible] crossings and adjacent girder rails in tangent track [illegible] often used as one of the best ways of making [illegible]. The particular feature of compromise rails which recommend them is that they permit the use of [illegible] joint plates or angle bars in making connect[illegible] dissimilar rail sections which are to be joined. They are quite often used in making connections between plain girder and groove girder rails in tangent tracks. Another use is for making temporary connections between new [illegible] rail sections which are dissimilar during the progress of reconstruction work.

The three general types of compromise [illegible] follows: (a) Welds, the cast steel or composite and (c) plates or bars. The weld type may be cast, thermit, electric bar or electric arc. The cast steel or composite type may be made of cast steel or a combination of cast iron fillers and regular bars or plates. The plate type includes all such joints made up by the use of bar steel planed and upset or regular plates and angle bars upset and offset by forging.

Method of Turning Railroad Type Shovel in Quarry

An interesting method of turning a railroad type shovel end for end in the shale quarry of the Colorado Portland Cement Co. is described by Mr. E. J. Stroek, in the December Excavating Engineer.

At this plant it is necessary to quarry, both shale and lime each day. In working the shale quarry each cut was carried lower than the preceding one. This gave the floor a stair-steps appearance, and made it impossible to have any great width of level floor on which to turn the shovel. It was expected to turn the shovel around when the cut was finished, and consequently the rails had been bent but no other preparations made.

The shovel suddenly ran into a pocket of gravel so extensive that it could not be stripped rapidly enough to allow continuing quarrying there.

The shovel, a 70 C Bucyrus, was backed to within its length of the place where the new cut was to begin, chains were disconnected, and the rear end of the shovel jacked up.

The rails had been bent to a curve, the radius of which was the distance between truck centers. These rails were bridled together and laid loose on ties laid at right angles to the length of the shovel, but curved in the arc of a circle. The rear truck was then swung at right angles to its usual position and lowered to the rails. The dipper hung free in front.

The rear end was then moved around the curved rails until the front truck jammed. Next the front end of the shovel was jacked up, the jack screws following closely in case a jack failed.

When clear of the rails, the front truck was swung around in the same direction as the rear was moving until the truck jammed, the short section of track fitted under the truck in its new position, the truck lowered and the rear end again pinched over. This was repeated until the shovel was facing in a direction directly opposite to its original one.

As a sample of the speed of moving, the rear end was swung around 14 ft. in six minutes. The front end was jacked up and trucks swiveled to their extreme position and set on the rails in 12 minutes.

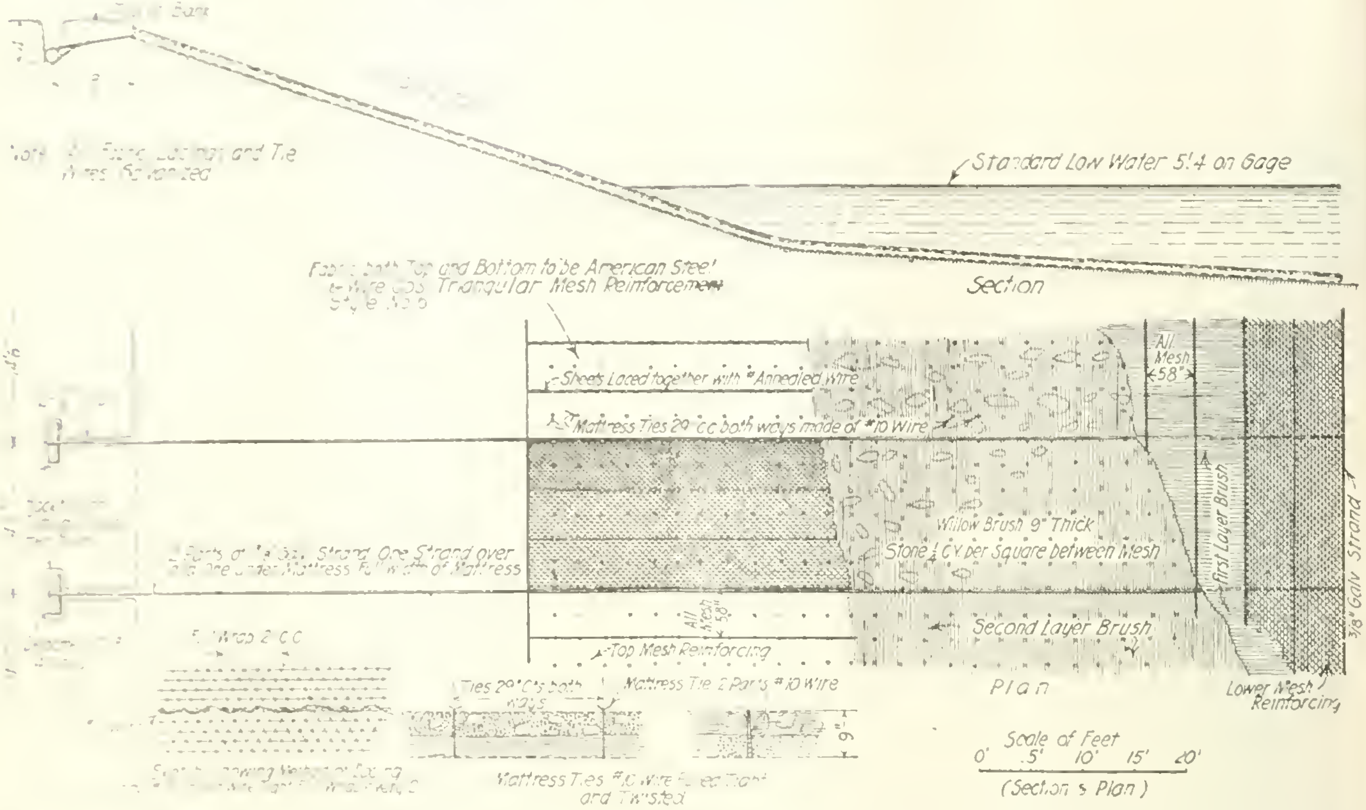
Illinois Central R. R. Appoints Commission for Chicago Electrification Problem. The Illinois Central R. R. has appointed a commission to consider and report upon the electrification of the Chicago Terminals of the company in accordance with requirements contained in the Lake Front Ordinance of July 21st, 1919. The commission consists of A. S. Baldwin, vice-president, chairman; D. J. Brumley, Chief Engineer, Chicago Terminal Improvement; Bion J. Arnold, Consulting Engineer, Chicago; George Gibbs, Consulting Engineer, New York; Cary T. Hutchinson, Consulting Engineer, New York; W. M. Vandersluis, Engineer-Secretary.

River Bank Protection Work on the Wabash Ry.

The following facts and illustrations are taken from a late issue of the Railway Review as an [illegible] of a recent example of river protection work on a large scale undertaken by a railroad. A number of railroads whose lines closely paralleling some of our larger rivers have in past years been obliged to adopt measures to prevent the washing away of their tracks and have had the benefit of all the experience gained by the army engineers who have been doing similar work for many years.

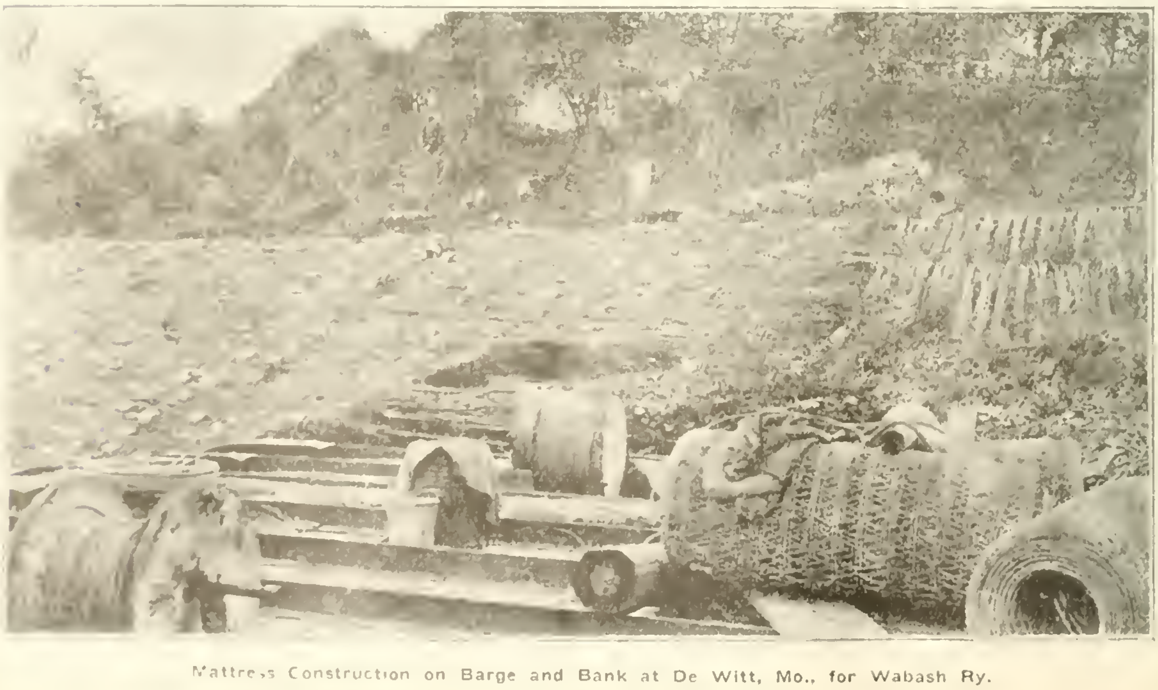
The Wabash Ry. is now constructing at DeWitt, Mo., an extensive brush revetment to protect the Missouri River bank from further cutting. This consists of a combination brush and wire mat with enough rock to hold it down.

The bank which is being protected at DeWitt is opposite the station and extends 2,500 ft. around a bend of the stream which has recently been rapidly cutting toward the railroad. The mattress consists of bundles of brush in two layers, at right angles to each other, underlaid with wire mesh in strips parallel to the stream. The bottom layer of brush is laid up and down the bank, or at right angles to the current, and the upper layer is parallel with the current. The upper wire mesh is in strips up and down the bank, or at right angles to the stream.


Top of Bank
Note: All Fabric Lacing and Tie Wires Galvanized
Standard Low Water 5.4 on Gage
Section
Fabric both Top and Bottom to be American Steel & Wire Co's Triangular Mesh Reinforcement Style No. 5
Sheets Laced together with #Annealed Wire
Mattress Ties 29" c.c. both ways made of #10 Wire
All Mesh 58"
Willow Brush 9" Thick
Stone ¼ C.Y. per Square between Mesh
First Layer Brush
Second Layer Brush
3/8" Galv. Strand
2 Parts of 3/8 Galv. Strand One Strand over and One under Mattress Full width of Mattress
All Mesh 58"
Top Mesh Reinforcing
Plan
Lower Mesh Reinforcing
Ties 29" C's both ways
Mattress Tie 2 Parts #10 Wire
9"
Scale of Feet
0' 5' 10' 15' 20'
(Section & Plan)
Mattress Ties #10 Wire Pulled Tight and Twisted

Plan and Details of Design of Cunningham Mattress for River Bank Protection, Wabash Ry.

The standard width of mattress is 70 ft. The quantity of rock used per 100 sq. ft. is one-fourth of a cubic yard, this being overlaid with the upper mesh and the mattress stitched through at intervals of 29 in. with No. 10 annealed galvanized wire, thus holding the rock securely in place. At intervals of 14 ft. there are anchor cables ⅜ in. in diameter, looped entirely around the mat and anchored to dead men at the top of the bank, as shown in the drawing. The willow brush



Mattress Construction on Barge and Bank at De Witt, Mo., for Wabash Ry.

Stretch of 1,000 Ft. of River Bank Protected by Cunningham Combination Brush and Wire Mattress at De Witt, Mo., on Wabash Ry.

used are ½ in. to 1½ in. in diameter and 15 to 20 ft. long, tied up in [illegible] bundles.

The cut bank at this point, being about 15 ft. high above ordinary stage of water, is first graded down hydraulically to a slope of [illegible] to 1, by means of a 4-in. hose with a 1-in. nozzle and a pumping outfit on a barge.

Premature Explosions in Quarrying from Sparks from Steam Shovels and Locomotives

A recent premature explosion in a quarry that resulted in the death of [illegible] men and the injury of several others, was directly [illegible] to a spark from a steam shovel working under the face directly in front of the hole being loaded. This accident and similar accidents of record in the Bureau of Mines indicate the necessity for pointing out the dangers [illegible] of explosives being ignited by sparks emitted from steam shovels and locomotives, and making recommendations for greater safety. In the November monthly report of investigations by the U. S. Bureau of Mines Spencer P. Howell ([illegible] Engineer, Bureau of Mines), and J. E. Crawshaw (Explosives Testing Engineer, Bureau of Mines) cite examples of premature explosions and give important recommendations for preventing such accidents.

Many premature explosions of which the following are examples have resulted from sparks, both from steam shovels and passing locomotives.

(A) The premature explosion occurred during August, 1920, at a limestone quarry, in a 100-ft. drill hole loaded with 1,000 lb. of high-grade nitroglycerin and gelatin dynamite. This hole had been loaded with 500 lb. of 75 per cent strength gelatin [illegible], 300 lb. of 60 per cent straight nitroglycerin dynamite and 200 lb. of 50 per cent straight nitroglycerin dynamite, but no tamping had been placed in the hole. The powderman loading the hole saw the spark enter the hole and was able to run a short distance before the explosion took place, thus escaping serious injury. The explosion of this first hole was transmitted to a nearby hole similarly charged. The [illegible] of rock from these two holes buried the steam shovel and some of the gang of men working around it.

(B) In September, 1909, in the Canal Zone, a steam shovel uncovered a misfired charge of dynamite. While the dynamite was being picked up the steam shovel continued working near it. A spark from the shovel set fire to some loose dynamite spilled on the ground from the broken cartridges. This fire was transmitted to a hole which was being loaded close by and caused a premature explosion. One man was injured.

(C) In September, 1912, in the Canal Zone, a spark from a passing locomotive set fire to a piece of paper near dynamite that was being loaded into a hole. The paper set fire to the loose dynamite cartridges, which in turn caused the detonation, without prior burning, of unopened boxes of explosives near by. None were injured.

(D) In August, 1907, in the Canal Zone, a hot cinder from a passing locomotive fell into a [illegible] of prepared primers, set fire to the dynamite and an explosion immediately followed. None were injured.

(E) In September, 1912, in the Canal Zone, a spark from a passing locomotive set fire to the explosive in a drill hole, causing a premature explosion injuring several men.

(F) In January, 1907, in the Canal Zone, a spark from a passing locomotive fell into an open black-powder can, igniting the powder. The other cans near by were in turn ignited, injuring several men.

Recommendations for Safety. From the above mentioned accidents, certain very important recommendations for safety can be made, and these should be carefully observed.

(1) The general principle should always be followed that workmen should never be allowed at the base of a quarry face within the zone of possible danger from falling rock after the work of loading the hole has begun, and the presence of workmen in the area between the line of holes and the face should be avoided.

(2) Before loading is begun, the steam shovel and locomotives should be withdrawn from the face of the quarry to such a distance that under no circumstances could sparks from them be carried to the explosive in the holes or on the ground above or around it, or if such equipment is not removed it should not be operated.

(3) If there is any unavoidable danger from sparks or cinders a canopy should be provided which will protect the explosive from flying sparks. A covered hopper may be used for black blasting powder.

(4) Where an unexploded charge is uncovered by the steam shovel, operations should cease until all of the explosive has been recovered and removed to a safe distance.

(5) Every piece of paper or other inflammable material should be removed from the vicinity where explosives are placed during loading operations.

(6) Primers should be kept in a portable metal box with a hinged cover and should not be stored close to the explosive, especially while the holes are being loaded.

(7) Unopened boxes of explosives should not be stored close to the hole being loaded but should be opened at a distance from it and brought up as needed.

Railway Mileage and Treated Cross Ties.—The following table from the 1920 Proceedings of the American Wood Preservers' Association shows the total mileage of steam, horse and electric railroads in the United States, and the total number of cross ties used:

Year	Total miles of track	Ties used	Ties treated	Per cent treated
1909	[illegible]81,149	114,440,700	22,033,000	19.25
1910	[illegible],171	117,141,000	30,544,000	26.08
1911	402,150	12[illegible],645,000	31,144,000	25.81
1912	411,177	12[illegible],143,100	32,394,000	26.24
1913	41[illegible],615	125,881,500	40,260,000	32.00
1914	428,612	147,5[illegible]2,500	4[illegible],847,000	31.77
1915	437,755	131,326,500	37,085,585	28.24
1916	441,765	132,564,500	37,169,368	28.10
1917	450,420	135,126,000	33,459,470	24.76
1918	451,000	136,200,000	30,609,209	22.47
1919	455,000	136,500,000	37,567,927	27.52

Engineers to Solve Transportation Problems

In a paper read before the Railroad Section of the Western Society of Engineers on Sept. 16, 1920, [illegible] A. Peabody, Signal Engineer of the C. & N. W. Ry., presented [illegible] on larger fields of usefulness for the civil engineer in railroad work. He emphasized the importance of working out of transportation problems in the broadest possible way by means of coordinating the work of the various departments and he enumerated some problems that it is believed engineers are peculiarly fitted to solve. His most important point, perhaps, is that engineers in the regular departments of engineering and operating have neither the opportunity nor the time for solving the broader transportation problems which call for careful analysis and breadth of view. An abstract of his paper follows:

Traffic is handled by the operating men over tracks furnished by the civil engineers, by means of locomotives and cars furnished by mechanical engineers and with the assistance of telegraph, telephone and signals furnished by communicating and signal engineers. But can you find where any one, engineer or otherwise, has planned the whole so that the parts will fit properly together? It is true that in the construction of new railroads something of this sort is done, generally by some one financially responsible, but there the matter has too often ended and the railroad has been left to grow, each part obtaining attention as some official directly interested in that particular part has brought it to the attention of the higher officials and obtained authority for expenditures.

When some big improvement is to be made such as a large terminal, an organization is often created which may make a study of the existing necessities and future requirements, but such an organization is more apt to be made up of men selected for their ability to carry out the work from plans and instructions laid down in such definite form as to leave little, if any, leeway and when that particular piece of work is completed the organization is generally disbanded.

Division officials are busy men; they have little time or opportunity to find out what others are doing and certainly neither time nor opportunity to make complete studies to determine what the possible requirements will be 20 years or even 10 in advance. Division officials are generally required to get along with what they have and ask for as little as possible; this, together with the other reasons mentioned, results in recommendations for improvements which a close study with full information would show to be entirely erroneous.

An efficiency engineer has been defined as an engineer who is ready to tell anyone how to do things which he cannot do himself, and far be it from me to recommend such an engineer to take care of this situation. I do believe, however, that there is a place on every large railroad for a man who with proper assistance makes a specialty of studying the transportation problems and such a man I believe can properly be termed transportation engineer.

As to just where in the railroad organization a transportation engineer would best fit would unquestionably vary on different railroads depending somewhat on the size of the railroad, more on the amount and importance of the work undertaken and most on the man.

There is probably today in every large railroad organization a man who due to his experience, breadth of vision, imagination and understanding of operating questions, together with good, sound judgment, is eminently fitted for the work of transportation engineering. Very often such a man would already have charge of some line of work and to start with transportation engineering could be added. However, I believe that where the proper man is selected it would not be long before he would have to devote his entire attention to the new work. In any event, in order to get the proper results a transportation engineer must be given absolute freedom in developing his plans and authority to call on any and all departments for such information as he may deem necessary and when the plans are completed his position must be such that he would naturally be called in consultation with the other officials such as vice president of operation, who would give the reasons for the necessity for additional operating facilties and the chief engineer, who will advise as to the best methods for the carrying out of the work.

Where such a separate organization is formed, there should be no fear that the transportation engineer would take from any of the present department heads, engineering or otherwise, any of their prerogatives worth retaining; on the other hand the gain would be so great as to far overbalance the objection. There would seem to be almost no limit to the possible scope of the work which might be brought under the term of transportation engineering because with the movement of both freight and passenger traffic to be studied, there must come studies of the growth of communities, mining, farming, urban, suburban and industrial, in order to determine the trend so that the necessities of the future may be foreseen and planned for.

The studies relative to handling of freight would not only be that relative to moving trains over the road, important as that is, but also that of handling freight trucks from the time that they approached the railroad property to the time emptied into the cars or freight houses and the freight thence to the made up trains, and of course, vice versa. The handling of passengers should also be analyzed in the same way as well as baggage, express, United States mail and railroad mail, which are each a problem and each of which has a relationship to the other which is too often overlooked.

While referring to the cost of operating trains, I wish to call attention to a number of the costs which should be looked into on almost every railroad. The cost of stopping trains and the relationship of that cost to the cost of preventing that stop. We, as railroad engineers, should be ashamed to acknowledge that today there is no complete information on this subject and to show necessity for such information, I would refer to a brief paper I wrote on this subject in 1905 and which is referred to even today, although the figures are entirely obsolete. A pamphlet (Bulletin No. 2) issued by the four largest signal companies, contains perhaps the best information there is today on thi subject, but it is anything but complete or satsifactory.

The cost of operating trains, not for the railroad as a whole, but for each engine division should be gone into in order to determine, if possible, how each may be cheapened.

The cost of switching in each yard should be known. In this matter I have been deeply interested lately, but so far in my investigation I have been unable to obtain accurate costs of switching trains; the men who have given me the cost of switching in certain yards themselves doubting their own figures.

The cost of handling engines at each terminal should be known to disclose where it would be advisable to make studies relative to reducing that cost.

Analysis should be made of each piece of congested main track and methods for increasing its capacity determined together with, of course, the cost of doing the work; the relative cost of operation also should be taken into consideration. In this connection not only comes the question of proper location of passing tracks as heretofore mentioned, but also there should be taken into consideration, signaling, interlocking, the dispatching system, reduction of grades and curvature and every other item that would go to make for economical operation.

It was my good fortune to be allowed to make up complete plans for passing track and signals for a certain piece of railroad. This was completed some three years ago, but complete analysis of the relative efficiency before and after has never been made; however, in making a brief survey a short time since it appeared that, with the same type of locomotive in use, the average time over the division for each freight train was 17 minutes less than before the improvements were made. It was not at all unusual for some trains to be tied up on account of time limit before the improvements were made, whereas this is practically unknown since. Previous to the improvements some trains were favored and consequently were moving over the road in a very short time; this accounted for the close comparison in average time. The surprising fact of the whole matter was, however, that under the new conditions the trains were averaging 50 per cent more tonnage per train than under the former conditions.

Analysis of large terminals should be made to determine whether the handling of cars cannot be reduced materially. In a large terminal such as Chicago the consolidation of some yards would reduce the transfer work and therefore the several handlings of a car. It would also materially shorten the time required to deliver a car from the road to an industry or vice versa.

In all this we must not forget the passenger service and in this connection it would seem that there are opportunities for materially increasing the revenue by decreasing the cost of operation, particularly in handling suburban traffic. Today I believe that the steam railroad engineer is very much behind the electric railway engineer in his knowledge of what can be done in this direction.

Shrinkage in Railway Fills

As an appendix to a subcommittee report to the Railway Presidents Conference Committee, Mr. H. S. [illegible], Valuation Engineer of the Chicago, Burlington & Quincy R. R., has given some valuable data relating to the earth shrinkage in fills, the determination of which was made by means of density tests.

The density method consists in comparing the weight of the net metallic content of equal samples of unmolested earth from an embankment and from the natural bed adjacent to the excavation which supplied material for the embankment. This net metallic content is taken as the weight of the sample after drying, the moisture content being eliminated by the heat. Difference in weight is taken as the measurement of change in volume.

At the point where a sample was to be taken, a pit was dug to the level of the top of the sample and then continued around the marked area of sample for a depth of about 18 in., leaving a pedestal of undisturbed material. For cutting the sample, a steel cylinder 10 in. long and 10[illegible] in. in inside diameter was used, having one end beveled to a cutting edge and the other end threaded for a screw cap. By means of a driving cap this cylinder was forced down into the undisturbed pedestal until the core projected above the top. The projecting earth was cut off level with the top of the cylinder and the cover was screwed on. The lower part of the pedestal was broken off with a shovel, the cylinder being then inverted and protruding earth sawed off level with the cutting edge. The sample thus taken was emptied into a closely woven sack and sent to the railway company's laboratory, where it was broken up and dried at 170° F. until by successive weighings no further loss in weight was obtained. In all, 89 samples were taken of clay, loam and gumbo in glacial drift formation in Iowa, Illinois and Missouri.

Some conclusions of the report are as follows: That earth, the metallic content of which in the natural bed weighs less than 103 lb. per cubic foot, shrinks when placed in embankment subjected to traffic, but when this weight exceeds 103 lb. the material retains a more or less permanent swell. As shrinkage bears a relation to weight and weight bears a relation to depth below the surface, the shrinkage of a fill has some relation to the depth at which the material occurred in the excavation; that earth obtained in excavation down to 4 ft. below the surface will shrink when placed in embankment, but that material taken at greater depths will swell. The former condition is the more important, according to the report, since ordinarily from 60 to 100 per cent of a railway embankment is of material obtained within the 4 ft. depth. Practically all side borrow falls in this class and the top 4 ft. of a railway cut contains a relatively large yardage on account of the trapezoidal section of the cut.

To show the effect of the loads and vibrations of traff
samples were taken of similar material from embankmen
which had been subjected to different conditions. Tests
these samples resulted as follows:

No. 1. Embankment 17 years old, built for future do
tracking but having no track laid. Shrinkage 6.7 per

No. 2. Embankment 49 years old but abandoned
years of traffic with light equipment. Shrinkag
cent.

No. 3. Embankment 17 years old and subj
of the heaviest equipment during the enti
age, 13.6 per cent.

With regard to subsidence under embank
reminds us that owing to the known high
content of surface soil, it is obvious tha
shrink when placed in embankments it wi
its natural bed by the load of the embank
of traffic, producing an apparent "shrinka
of subgrade. It is concluded that under
Iowa this will add 3 per cent to the a
the embankment.

g
n
nd
Or
The
workmen's
ected by the
and are rotated
are further in
between the var
and logging opera
idering accident re-
receives and files a
as said that the plan
, that it was too com-
handling by the type
ks. So it would prob-

An Engineer in the Metropolitan Museum of New York

By F. P. [illegible]

[illegible]

Many engineers who [illegible] the Metropolitan Museum of Art [illegible] of [illegible] Hearst's Evening Journal [illegible] "The [illegible] of the World." An hour or many [illegible] there entertainingly and profitably. Take [illegible] avenue [illegible] to 82nd street. Admission is free except [illegible] when 25 cents is charged. As you enter [illegible]. A dozen Egyptian rooms show how [illegible] of the millions of people in the Nile Valley changed during four thousand years—a land of hot, dry [illegible] yet fertile because of the life giving great river.

Six thousand years ago the Egyptians [illegible] modeled vases of alabaster, diorite, slate and limestone, made gold ornaments and glazed beads and worked copper into fish hooks, although the convenient flint was still used for knives and arrow heads. Their dead were not mummified then but were interred in sandy graves on their side with their knees drawn up, the head placed to the south and the face toward the west. Because of the peculiar qualities of soil and climate, many of these bodies have been found desiccated but well preserved. With them, as with our American Indians, were buried weapons, vases of food and articles of adornment.

Centuries later mummification was introduced and grew increasingly popular and more complicated until death became as intricate as American life is today. The body was treated with natron (sodium carbonate), and swathed carefully in linen, after the viscera had been removed for keeping in canopic jars. Mummies, coffins, granite sarcophagi, and limestone tombs can be seen in the Museum, erected just as they lay in Egypt. This ancient people was extraordinarily concerned with what happened after death. A detailed set of directions for the soul, called "The Book of the Dead," was placed with the mummy, and many hieroglyphics were inscribed on the coffin and tomb. It was thought that the deceased would be asked many perplexing questions in the ordeals of his initiation, besides having his heart weighed by Osiris. He might even forget his own name, and wander forlorn through all the hereafter. Tiny statues of the deceased, sometimes to the number of several hundred, were inscribed with responses for the tasks that he would encounter, and buried with the body. The walls of the tomb were covered with pictures of servants bearing food and drink, to lend prestige to the soul on his long journey; and real offerings were brought to important tombs and left, which no doubt pleased the priests.

The engineer visiting the Museum will be especially interested in the workings in metal, such as bronze mirrors, copper axes, iron knives, carpenters' tools, etc. Glass was used for ornaments, but not for windows, being colored a [illegible] rated. Though the Egyptians were hamp [illegible] be stated a tradition in their reasonable expectation and in some respects to have been more than was really anticipated. Of course, there have been foremen, even in the more important departments, who have taken to the work slowly and with [illegible] indifference. They say that it was not done at such and such a place where they came from and had their training, and that "they didn't kill so many there," and that "it is a lot of extra trouble and humbug for nothing." There are still men in the ranks who continue to regard the whole program with a smiling tolerance to be endured until, as they think, the enthusiasm which is now apparent shall have time to die down, and it is not to be doubted that there are yet a few who even look hopefully to a day when, as they expect, the same old system of carelessness and indifference to results may have sway as in the past. But in contrast to them are other foremen who have taken and are continuing to take genuine and sincere interest in the work and are determined to make it a lasting success, and such foremen are being followed cheerfully by their men.

A Test of Efficiency.—The time has now arrived when the management is beginning to take definite note of the fact that the efficiency of both foremen and men is fairly accurately gauged by the direct interest taken by them in the safety work. Or, to state this proposition in other words, the management is now finding that the value of the individual em-

[illegible] its general expression of serene [illegible] is not unlike that of a gentleman named Harding from Marion, Ohio.

The Greek exhibits suggest a different atmosphere, though even Professor Gilbert Murray, of Oxford, admits that ancient Athens had idols nearly as vulgar as ours with prejudices fully as terrible. However, the wonderful vases and statues on exhibition indicate that art and culture ranked immeasurably higher in the Hellenic cities than it does in the much larger communities that our present day knowledge of science have made possible. A stroll through these classical reminders brings intimations of the vast field of the imagination which we moderns have been too busy to cultivate.

One of the most daring of the Greek philosophers, Anaxagoras, conjectured that the sun, which was an object of great interest to the primitive peoples, was "as big as all the Peloponnesus"; this is about equivalent to saying that the sun is as large as the Panhandle of Texas. Many of their guesses about science, for instance the atomic theory of Democritus, were surprisingly bold for the times, yet H. G. Wells says in his "Outline of History": "A modern scientific man dumped down in the Athens of Pericles would have found the utmost difficulty in demonstrating the elements of his knowledge, however crudely, to the men he would have found there. He would have had to rig up the simplest apparatus under every disadvantage, while Socrates pointed out the absurdity of seeking Truth with pieces of wood and string and metal such as small boys use for fishing. And he would have been in constant danger of prosecution for impiety." Yet never has there been a race so sensitive to beauty and so capable of expressing it in art.

Most engineers, of course, would agree with Mr. Wells that civilization has made enormous progress since then, in spite of all the blunders. Yet gloomy Dean Inge, of St. Paul's cathedral, London, objects to this conception of progress, which he says does not consist in discovering the size of the sun or in building railroads and factories. Even Mr. Wells points out misconceptions: "The last twenty-three centuries of history are like the efforts of some hasty immortal to think clearly and live rightly . . . Wherever in any man the great constructive ideas have taken hold, the hot greeds, the jealousies, the suspicions and impatience that are in the nature of every one of us, war against the struggle towards greater and broader purposes." Such are one's thoughts in the Museum as he wanders among broken fragments of civilization that seemed, at their time, the mightiest and most endurable of forces.

Upstairs are the many paintings for which the Museum is famous, inspection of which should not be omitted unless time is short. Also upstairs are elaborate and interesting exhibitions of Oriental art, European furniture, and other oddities. The [illegible] visiting New York should spend some unhurried [illegible] in the greatest art museum in the Western Hemisphere.

[illegible] ne 44-In. **Steel Riser with Oxy-Acetylene Flame.** A the tra[illegible] ri[illegible]r at the plant of of the National Car properly be termed [illegible] was [illegible] with the oxy-acety-

As to just where in the railroad organization a [illegible] cause of [illegible] engineer would best fit would unquestionably vary on different railroads depending somewhat on the size of the railroad, more on the amount and importance of the work undertaken and most on the man.

There is probably today in every large railroad organization a man who, due to his experience, breadth of vision, imagination and understanding of operating questions, together with good, sound judgment, is eminently fitted for the work of transportation engineering. Very often such a man would already have charge of some line of work and to start with transportation engineering could be added. However, I believe that where the proper man is selected it would not be long before he would have to devote his entire attention to the new work. In any event, in order to get the proper results a transportation engineer must be given absolute freedom in developing his plans and authority to call on any and all departments for such information as he may deem necessary and when the plans are completed his position must be such that he would naturally be called in consultation with the other officials such as vice president of operation, who would give the reasons for the necessity for additional operating facilities and the chief engineer, who will advise as to the best methods for the carrying out of the work.

Results Obtained from Plan of Safety Organization for Lumbering Operations

A 51 per cent reduction in lost time, a 13 per cent reduction in the number of accidents, a 30 per cent reduction in the cost of caring for injured employes, a material reduction in labor turnover, and a 10 per cent increase in production (with a decreased working force), were some of the results obtained from a plan of safety organization put into effect this year by the Edward Hines Company for its lumbering operations in Mississippi. The plan was described by Judge V. A. Griffith in a paper presented Sept. 30 before the Woodworking Section of the Ninth Annual Congress of the National Safety Council. An abstract of the paper follows:

Educational Work and Safe-Guarding.—Having observed the satisfactory results obtained by systematic safety organization in other lines of endeavor, and having the faith that by continual effort the difficulties in the way could be finally obviated, it was determined toward the end of last year by the Edward Hines management in Mississippi to adopt such a plan for their lumbering operations in that state, and to do so upon a thorough and comprehensive basis, just as if their plants had existed for years and expected to continue in operation for all future time to come. Although in order to make it reasonably certain of success it was determined to place it upon a compulsory basis throughout, it was appreciated in the very beginning that unless the interest of the men could be enlisted upon some other than a compulsory basis, the plan could not attain that measure of success which would make it really worth while. So a plan of organization was prepared and put into operation, whereby the voluntary co-operation of the men was sought and emphasized to the highest practical degree.

To create among the employes a receptive mental attitude, preliminary meetings were held and safety literature distributed. They were shown, first, that by far the larger percentage of accidents in saw mills and logging operations was preventable, and second, that the impression that the majority of accidents resulted from defects in machinery, appliances, etc., was entirely erroneous, but that, on the contrary, more than 70 per cent of all accidents resulted from carelessness, thoughtlessness or inattention on the part of the men themselves.

The point was emphasized that the success of safety work depended, in a large part, upon the workmen themselves, and only in a small part upon the plant equipment. It was especially promised, however, that the management would at once start to install safety devices and guards not only in all places where such devices had been originally intended, but that all possible efforts would be made to design and install other and further safeguards and safety appliances in order to eliminate the proportion of the accidents, resulting from faulty equipment.

As a further assurance or guaranty of this, the position of general safety inspector was created and a special crew of men was put to work under his direction to install the guards and safety devices mentioned. This work was faithfully carried on throughout the plants in such a way that the men, in their daily work, were reminded as constantly as practicable that the company was redeeming its promises, and at the same time, they were impressed with the earnestness and fixed purpose of the management to make safety a real and genuine part of the operations.

The Suggestion System.—Furthermore, the men themselves were encouraged to co-operate in the matter of suggesting and ments we safeguards. Suggestion boxes were placed in each Previous to the employes were invited to make suggestions consequently to place them in the box, the company promthis accounted suggestion would receive respectful consid- The surprising [illegible] worthy of adoption would be adopted and under the new [illegible] person making the same. A system of cent more tonnag[illegible]able suggestions was instituted, so that tions. [illegible]nse of pride in the men appealed to by

Analysis of large [illegible]on thus to join in a creative work of whether the handli[illegible]entive of immediate pecuniary gain was In a large termina[illegible]as been that not only have many valusome yards would [illegible] safety been received through the sugthe several handling [illegible]ggestions beyond the scope of safety shorten the time req[illegible] the value of the suggestions thus rean industry or vice [illegible] side of the scope of safety, has been equal to or in excess of the total cost of everything done or spent in the safety work. For instance, a negro made a suggestion through the suggestion box which when examined was found not to apply to safety but was so valuable as an operative measure that he was awarded a substantial cash prize. The suggestion was immediately utilized at a cost of $40 and is now resulting in a saving of $200 per month in the expense of the operation.

A white man made a suggestion by which [illegible] ft. of trestle costing $5 per foot were saved, and many like illustrations could be given. The spirit of cooperation and good will on the part of the men appealed to by these various features of the program has manifested itself in several ways, the labor turnover has been steadily reduced, and although the total working force has been slightly decreased, the aggregate output has been increased by 10 per cent. It is felt, therefore, that even if the organization which was adopted had not reduced accidents nor prevented injuries and suffering, it would have more than paid for all its costs in money, time and effort by the reduction of operating expenses, by lowering the rate of turnover and by increasing the output with a decreased force. But, the results which have been obtained in the prevention of injuries have been equally satisfactory, especially when all the obstacles which had to be overcome are considered.

Outline of Plan.—The plan of safety organization which was adopted was designed fundamentally to appeal to the interest and best human qualities of the men from the lowest grade in the ranks to the general manager himself. The organization embraced two saw mill plants and two logging operations which extend over an area of some 50 miles north and south, and employ a force of about 1,200 men. The safety work of each plant and its logging operation is under the direct supervision of a general committee, consisting of a chairman, the general inspector, the superintendent, the auditor, and the saw mill foreman. The second element of the organization is the general inspector, whose duty it is to encourage active efforts in each unit, to assist and guide in the work in general and to form the main co-ordinating link between them all. The third unit is the foreman's safety committee, consisting of five foremen at each plant or logging operation, and working closely in conjunction with them is the fourth unit, the workmen's safety committee, consisting of five white workmen and a separate colored workmen's safety committee consisting of three colored workmen. The fifth unit consists of the foreman of each department, and the sixth of the weekly safety overseer of each department.

Throughout the organization, the fact is clearly emphasized that the foreman is the most important unit and that his attitude toward safety determines very largely what will be the attitude of the men under him, and the foreman is impressed, by every possible means, with his position of leadership and with the necessity of his sincerely maintaining the same in all good faith and perseverance, if his work is to succeed and if he expects to rank well in the esteem of his superiors. The foreman is further impressed with the increased opportunity which safety affords him to get on terms of close human relationship with his men, whereby the men may be made to feel more than ever that the foreman (if he be the right kind of a foreman) is their friend and helper, and that his chief concern is, as it ought to be, their welfare and success in their work in all respects, not alone in safety.

To [illegible] the interest and [illegible] of the foreman, they are [illegible] in committees, each committee serving three months. They are given broad privileges as to inspection, reports and recommendations. They also visit and inspect the other plants and operations of their employer, and on certain occasions, the plants of other companies. On these trips they receive their full time and expenses. The same general duties and privileges are allowed the workmen's committees; these committees, however, are elected by the men themselves for terms of three months and are rotated as to personnel.

The spirit and interest of the organizations are further increased by means of a plan of competition between the various units. Every three months the plant and logging operation which makes the best record, considering accident reduction and increased interest in safety, receives and flies a safety flag for the following three months.

The General Inspector.—By some it was said that the plan was too elaborate for a lumber operation, that it was too complicated for the comprehension of, and handling by, the type of men found as employes in such works. So it would probably have proved had it not been for the coordinating agency of the general inspector, whose duty it has been to explain the details of the plan to [illegible] and to see that all points of the safety [illegible] are properly carried out. With his aid and constant [illegible] the plan has been made to work and work well producing results which have been a source of gratification to all concerned, from the standpoint of operating expense and production as well as from that broader and humanitarian one of reducing accidents and suffering.

The Reduction of Accidents and Time Lost.—It is required that every accident however trivial in its nature must be formally reported and that the injury, even if it is merely a break of the skin must receive immediate medical attention, the entire expense of which is borne by the employer. Thus has been reduced, to a fair minimum, the suffering and loss which formerly resulted by infection from apparently trivial injuries. First aid kits and first aid stations have been installed throughout all the works and the workmen's safety committees and all foremen are trained by the surgeons in their use, so that the results of injuries, formerly rendered serious by reason of neglect or necessary delay in obtaining medical attention, are minimized, both as to suffering and loss of time. The accident frequency rate (these figures include every kind of accident even the most trivial) has been reduced in the mills from 70 per 1,000 men per month to [illegible] per 1,000 men per month, and in the woods operations, while the frequency rate has not been substantially reduced, there has been a striking reduction in the severity rate or the days lost per man per month. As a matter of fact, the frequency rate has been improved considerably more than the above statements would indicate, because of the fact that more nearly all accidents are being recorded than heretofore. Foremen are being trained to be more and more careful to report every injury, no matter how slight, and accidents are now being reported which formerly were not noted at all.

The Saving in Caring for Injured Men.—A substantial saving in the expense of caring for injured employes has resulted. Although there is no workmen's compensation law in the state of Mississippi, the company is paying half time for all time lost on account of injuries received, and is also paying for surgeon's attendance, drugs, etc., including hospital bills for all cases where such treatment is necessary. These expenses are borne without regard to the question of legal liability; in other words, without regard to whether the injury was received through the fault of the employer or of the employe. In spite of this extra-legal and far more liberal policy of compensation, the total cost to the employer during six months of organized work has been less by approximately 30 per cent than was the cost during the six months prior to the adoption of the plan. It is to be noted that in the present estimate, everything that is spent for the maintenance of the safety organization, including the salary of the general inspector and all other agents and employes of the safety and casualty departments, are charged into this cost, and yet, as just mentioned, there has been the substantial saving of 30 per cent already accomplished.

The Effect on the Foreman.—The results in the short time of but little more than six months may, therefore, be stated as equalling every reasonable expectation, and in some respects to have been more than was really anticipated. Of course, there have been foremen, even in the more important departments, who have taken to the work slowly and with ill concealed indifference. They say that it was not done at such and such a place where they came from and had their training, and that ‘they didn't kill so many there,’ and that “it is a lot of extra trouble and humbug for nothing.” There are still men in the ranks who continue to regard the whole program with a smiling tolerance to be endured until, as they think, the enthusiasm which is now apparent shall have time to die down, and it is not to be doubted that there are yet a few who even look hopefully to a day, when, as they expect, the same old system of carelessness and indifference to results may have sway as in the past. But in contrast to them are other foremen who have taken and are continuing to take genuine and sincere interest in the work and are determined to make it a lasting success, and such foremen are being followed cheerfully by their men.

A Test of Efficiency.—The time has now arrived when the management is beginning to take definite note of the fact that the efficiency of both foremen and men is fairly accurately gauged by the direct interest taken by them in the safety work. Or, to state this proposition in other words, the management is now finding that the value of the individual em-

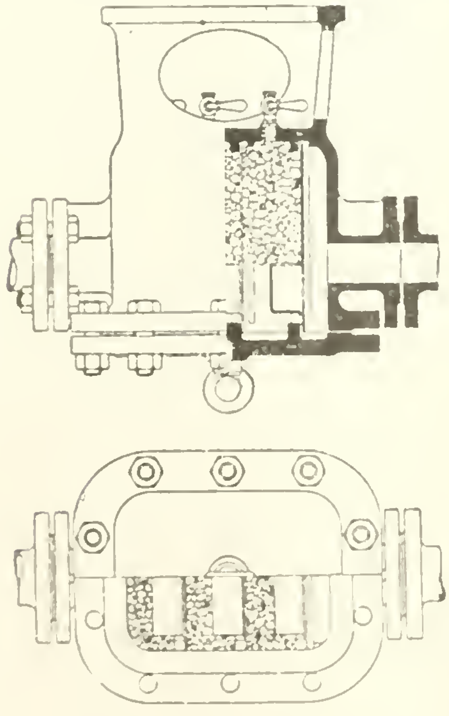
[illegible] as a [illegible] be [illegible] in, is very nearly in direct proportion to the [illegible] that employes is taking in the matter of aiding [illegible] the advancement of safety work. There [illegible] of the plan has just about reached the stage [illegible] reach it where it will be necessary for the [illegible] in order to make absolutely secure the success and [illegible] the continued increasing success of the plan, to [illegible] out of the service as tactfully as can be done [illegible] will not actively take part and aid sincerely in the [illegible] of the plan and in its purposes from beginning to end. Especially will this be applied when considering the retaining of indifferent foremen. It is inconceivable that [illegible] intelligent management with the result before it which has been accomplished in so short a time will not take the requisite steps in this connection, unpleasant as it may be to any management to sever relations with some employes who have been long in the service.

The Results.—To sum up the results: There has been created a feeling of closer personal relationship between employer and employe and a stronger sense of loyalty and good will. The labor turnover rate has been reduced, and with a smaller force, there has been a 10 per cent increase of output. Through the installation of suggestions made by the men, the cost of operations has been reduced to an amount more than equaling all that has been spent for safety and for the maintenance of the safety organization, the accident severity rate has been reduced 50 per cent, the frequency rate 40 per cent, and the total cost of the safety and casualty departments, on a much more liberal basis than ever before as to allowances, has been reduced 30 per cent below all previous costs for like periods; and with it all, there is the greater and more genuine satisfaction that there has been put into the work the spirit of humanity, of kindness and of patriotism, which, to every good man, outweighs mere dollars and cents beyond any thought of comparison.

Air Filter and Trap for Compressed Air Lines

A filter and trap for air pipes that is stated to have been in successful use since 1914 at the Gneisenau Pit, Germany, is described in November Compressed Air Magazine.

The filtering material consists of small, angular, rough lumps of crushed flint, which the compressed air has to pass through on its way. According to a published description, the air arrives with great velocity in the first air chamber where it is deflected 90°. It leaves the air chamber through an opening in the bottom and is blown through the interstices between the lumps of flint, rising into the next chamber. The flints in the water trap intercept all dirt and moisture, and the air emerges thoroughly cleaned and dried. As to the drying, this can mean only that the actual water in its condensed form will be removed, with no effect upon the water vapor, which might still be present in the air up to the point of actual saturation. It is stated that the air pressure is not affected by the insertion of the trap in the pipe line, as proved by measurements, which would be true only if the passages provided were of sufficient area.



Filter and Trap for Air Pipes.

Fundamental Ideas in the Transportation Act

In an address before the annual meeting of the Massachusetts Chamber of Commerce at Boston, Mr. Alfred P. Thom, General Counsel of the Railway Executives, reviewed the railway history of the country very briefly and showed the causes which led up to the passing of the Transportation Act. These causes are perhaps by now well enough understood by at least a large part, if not the majority, of the public.

Mr. Thom is undoubtedly echoing the belief of most railway executives when he states that the Transportation Act is an economic triumph of popular government, and that "it furnishes new assurance and gives fresh courage and hope to those who believe in the good sense and the spirit of wisdom and statesmanship which reside in the masses of the people and which will ultimately manifest itself in the system of laws evolved out of public opinion.

Men may still debate as to the adequacy of the legislation which has been adopted, but there can be no reasonable difference of opinion as to the soundness or value to the nation of the new conception that has been accepted of the responsibility of government to the subjects which it undertakes to regulate and of the recognition of the fact that the credit of these carriers, on which their ability to perform their essential public service depends, is a matter of profound and vital public concern, and must, out of regard for public welfare, be dealt with on reasonable and sound business principles."

The fundamental ideas in the act as given by Mr. Thom are as follows:

That transportation is a business in which the public is vitally interested.

That the system of private ownership and operation, invigorated and vitalized by individual initiative and enterprise, is in the public interest to be preferred to government ownership and operation, and that it is more equitable to distribute the cost of supporting it among the persons who use it in proportion to their use, than to impose it on all the people on those who do not use it as well as on those who do—irrespective of their use, by levying it as a universal tax and paying it out of the public treasury.

That the business of transportation must be treated as a business and that unless so treated it cannot survive and perform its fuseful and essential public purpose.

That the Government cannot, in conscience or with due regard for the public welfare, exercise the power of regulation, which involves the restriction of business opportunities, without at the same time accepting the responsibility of seeing that justice is done, proper encouragement and support afforded, and that the charges for transportation, while limited so as to prevent injustice to and extortion on its users, are reasonably sufficient to attract the capital needed to make and keep the facilities of transportation adequate to the public needs.

That, therefore, the proper financial credit of these carriers is primarily and principally a matter of public, and only in a minor degree of private, concern; for on the adequacy of such credit, the supply of transportation is, under the system of private ownership, dependent, and the system cannot be abandoned for any other without profound influence on, and grave consequences to, our chosen and established governmental institutions.

Bulletin on Storage Battery Locomotives. The U. S. Bureau of Mines, Washington, D. C., has recently issued Technical Paper 264, "Preliminary Investigations of Storage Battery Locomotives; Specifications, Laboratory Tests, Permissible Schedule'," by L. C. Ilsley and H. B. Brunot, electrical engineers of the Pittsburgh Experiment Station of the Bureau of Mines.

Principles of Tie Plate Design

The use of tie plates on American railways is still in somewhat of an experimental stage notwithstanding the fact that there are millions in use and that there is no longer any argument as to their economy. Since their first introduction tie plates have undergone an evolution from the deep pronged, deep-ribbed or deep-lug type to the present-day practically flat type, but this flat type has many variations.

Mr. Howard H. George, Assistant Engineer Public Service Railway of New Jersey, writing in the Electric Railway Journal, has reviewed some principles of tie plate design and use. The following is taken from his article:

The question of tie-plate design and its effect on the tie is one of the important problems that confronts the track maintenance engineer. It has received a great deal of attention and study through the efforts of the various committees of the American Railway Engineering Association under whose direction a number of tests and experiments have been made.

There has been much discussion among steam railroad engineers as to the minimum thickness of plates required at the edge of the rail base. Some have argued for a minimum of ⅜ in. while others have maintained that a thickness of ½ in. gives more satisfactory results. Of course it is entirely a matter of respective loading and the kind of timber in the tie on which the plate is used. In the case of electric railways it is not felt that the load requirements would ever justify specifying a thickness in excess of ½ in. and a thickness of 7/16 in. will generally be found to be ample, regardless of the kind of timber in the tie.

Some railroads are using an inclined tie plate, the maximum thickness of which is ¾ in. and the minimum less than ⅜ in. In addition the plate is cambered lengthwise of the rail, this giving a line contact instead of a surface contact between the rail base and the tie plate, which line of contact is always at some point between the two edges as the rail flexes under moving loads. It eliminates the concentration of the load on the near and far edges of the tie plate as the loads approach and recede. One large railroad has adopted a tie-plate of this design as its standard. The inclination tilts the rail inwards and is designed to make the resultant force due to a wheel load on the rail and the wedging action due to the coning of the wheels, which are at right angles to each other, coincide with the center of the rail. Some few engineers have at various times argued to eliminate coning, but they evidently were not very well informed as to the reason for its use. As a matter of fact, it is absolutely necessary for the safe operation of a railroad. Wheels were first made with flat treads, but they soon tore to pieces the metal strips used for rails and the wheel flanges as well, so that it early became necessary to introduce coning as a matter of safety. It eliminates excessive rubbing of the flanges against the side of the rail head. When the flange approaches the rail that wheel is turning on a larger diameter than the other wheel on the same axle, and because they are rigidly fixed on the axle the wheels are caused to swerve in the other direction slightly until a corresponding action takes place on the other rail.

Tests have been made at Purdue University to determine the relation of the crushing strength of different ties with and without tie-plates. It was found that the fiber stresses per unit of area of the wood under the tie-plate at the elastic limit in the case of the oak tie were less than those under the rail alone with the exception of one type of tie-plate that was tested. Of course, the total load was greater. This was accounted for by the perceptible springing of the tie-plates, thus producing a non-uniform pressure on the wood under the plates. Therefore, the loads carried with the aid of the tie-plate, while larger, were not increased in the same ratio as the increase of the bearing surface. In the loblolly pines and in the case of one type of tie-plate tested on red-oak ties, no perceptible springing of the tie-plates was observed within the elastic limit of the timber, the load being increased in practically the same ratio as the surface. These facts must be given careful consideration in designing tie-plates for use with any particular kind of timber. The primary purpose or function of a tie-plate is to protect the tie from mechanical wear, and all other functions should be subordinated to this. Of course, the brace tie-plate also must act as a brace and care must be taken in its design to obtain a good fit and in the specifications to see that the permissible variation in the dimensions shown does not defeat this object. Assuming, however, that the tie-plate will be of sufficient area properly to distribute the loads imposed, and that it is of sufficient thickness to prevent buckling, it is necessary that the movement between tie plate and the tie be reduced to a minimum or eliminated if possible. Otherwise, due to impact, the force of the blow delivered soon crushes the tie and renders the tie plate ineffective, the crushed wood fibers permitting the retention of moisture and hastening decay. Also care should be taken to see that there is no chance for lateral movement of the rail across the plate and that the distance between the inside faces of the spike holes is not greater than the width of the rail base. Excessive rail movement causes excessive wear on the spike itself and should be prevented as far as possible.

It is recognized that it is the best practice to require that all holes be punched from the top of the plate. This insures a smooth surface for the rail bearing. However, there may be special cases where holes will have to be punched from the bottom, where it is not practical to punch from the top.

Probably no other track fixture deteriorates so rapidly from rust as the tie-plate. Many engineers favor coating all plates with oil before shipping from the mill to retard this corrosive action as much as possible. However, opinion as to the value of such an oil coating is divided. The New York Central R. R. made some tests a few years ago of some steel plates coated with linseed oil and found that they began to rust within two or three months when exposed to ordinary weather conditions. Since storage of such fixtures as tie-plates is generally made in the open or under open sheds, they are more or less exposed to the weather and corrosion is apt to be very rapid, especially where they are exposed to salt air. On our own property, it has been the practice to require the manufacturer to coat all tie-plates with red lead before shipping, and this has been found to give excellent results. If not protected in some way, steel tie-plates are very apt to go to pieces very rapidly before they get into the track.

The inspection cost of the plates is very small. It amounts to only about 20 ct. per ton at the present time.

Cross Tie Tables.—The following table from the Nov. 20 Cross Tie Bulletin of the National Association of Railroad Tie Producers shows the board feet and cubic feet per tie, number of ties per 1,000 board feet, gallons of creosote and pounds of zinc chloride per 1,000 ties under specified treatments for the more common sized sawed ties. The table was compiled by E. M. Blake:

Dimension.	Board ft. per tie.	Cu. ft. per tie.	No. of ties per 1,000 board ft.	Gals. of creosote per 1,000 ties sp. grav. 1.0436, or 8.7 lb. per gal. treated under Rueping process. 7.5 lb. per cu. ft.	6.0 lb. per cu. ft.	Lbs. of zinc chloride per 1,000 ties at ½ lb. per cu. ft.
LENGTH, 8 FT.						
6"x8"	32.00	2.66	31.25	1,686	1,839	1,333
7"x8"	37.33	3.11	26.80	1,967	2,146	1,555
7"x9"	42.00	3.50	23.80	2,212	2,414	1,750
7"x10"	46.66	3.88	21.43	2,459	2,682	1,944
LENGTH, 8 FT. 6 IN.						
6"x8"	34.00	2.83	29.41	1,791	1,954	1,417
7"x8"	39.66	3.31	25.21	2,091	2,281	1,654
7"x9"	44.62	3.72	22.41	2,351	2,565	1,860
7"x10"	49.58	4.13	20.17	2,612	2,850	2,066

Stripping a Sand Pit by Blasting.—Stripping at the sand pit of the Washington Sand & Gravel Co., near Bladenburg, Md., is done by blasting with dynamite, 4 to 6 ft. of top soil being removed in this way. These pits are located at the side of a creek and the sand is loaded on boats by means of a floating suction dredge operated on the creek. A recent shot was loaded as follows: Bore holes were put down vertically, 4 ft. deep and located 8 ft. back from the creek bank. In this shot, there were seven charged holes, 2½ ft. apart, in the row. Five cartridges of 40 per cent ammonia dynamite 1¼x8 was the charge in each hole. Each charge was primed with an electric blasting cap and the firing done with a blasting machine. The shot removed the top from the section blasted, throwing most of the dirt into the creek. It is figured that the cost of the blasting is more than balanced by the saving in the time and cost of operating the dredge to remove the top. This work was all waste, because no use could be made of the top soil.

The Superpower Survey

The following is taken from a report of Mr. William S. Murray in the September bulletin of the American Railway Engineering Association on the Superpower Survey which has been started under his direction:

The United States Government has recognized the appeal made by a committee representing the engineers of this country who appeared before the Appropriations Committee of the House of Representatives in April to present the case of the superpower system, and both houses of Congress have now approved the superpower survey for the zone on the north Atlantic seaboard between Boston and Washington and inland from the coast averaging 150 miles, and have granted an appropriation in the amount of $125,000 with which to carry on the work.

The plan has for its central idea the construction of an electrical regional power system applicable to the industries and railroads existing within the territory between Boston and Washington and inland from the coast 150 miles.

In this area, which is less than 5 per cent of that of the United States, there is installed a machine capacity aggregating 17,000,000 HP; 10,000,000 of this is required to run the industries, 7,000,000 is required to operate the railroads.

By the installation of high-powered, high-economy tidewater steam and hydroelectric stations and steam stations located at the mouth of mines, within the territory named, all interconnected with a transmission system, using also the large central stations now built and located at the larger cities such as in Boston, Providence, New York, Philadelphia and Baltimore there can be integrated one great regional power system from which power can be delivered to the industries and railroads. Such is the proposed modification to our present power practice. What will be the result? The following.

1. At $5 a ton the coal saving will be $150,000,000 per annum.

2. The maintenance savings due to electric versus steam drive in the factories and on the railroads, plus the savings to be gained in the reduction of train-miles by virtue of the ability of the electric locomotive to consolidate greater tonnage in single trains, will be $150,000,000 per annum.

3. There will be created a "common carrier system of power," lifting the coal off the rails and automatically opening up cargo space for the haul of more valuable and higher-priced commodity.

4. Operation will be speeded up in large switching yards and passenger terminals, thus greatly increasing track capacity without adding track mileage or equipment due to the greater facility of control in the three classes of service—passenger, freight and switch.

5. There will be delivered a cheap and reliable electric power at the doors of all industrial workers, replacing the antiquated and wasteful steam engine and thus facilitating multiple production.

6. There will be saved the labor of the miner, the maintenance of the tools he used in mining, the maintenance of and cost of operating the equipment that hauled the ton of coal—which was only to be wasted after traveling maybe [illegible]00 miles.

7. While we are throwing away one ton for every two taken out of the ground, the hole is getting deeper, the lift is getting more costly and we are exhausting the great eastern coal fields. Except for those who are too blind to see, this can mean but one thing—namely, that the cost of coal is on the upgrade and there is no summit to the grade. But we can at least lower the percentage of that grade.

Two great fundamental factors stamp this matter as one of national importance. They are:

1. It stands preeminently for the conservation of the nation's natural resources.

2. It provides a tool which is the kinetic embodiment of real force to speed up, increase, and maintain production in this country at high efficiency.

It is quite natural that something that can save so large a sum of money must be large in itself. The investigation and report would not be complete without the inclusion of a plan looking toward the financing of the project, and such a course of procedure should be outlined quite as definitely as the system which will eliminate these wastes. I believe, however, it is far more important first to allocate these wastes and their amounts so that when equated in dollars and cents they will form a solid foundation upon which to base financing. The part, therefore, that the Government is playing in this matter is only to finance an administrative and engineering force to show clearly what these wastes are: and this force has been organized and is known as the Superpower Survey, with headquarters at 709 Sixth Ave., New York City.

The zone I have described is the most congested railroad and industrial district in the United States, but there are others that are due for investigation of a similar character. In short, it may be said that the project makes toward the establishment of a national power policy, and the other districts will be electrified in the order of their power density.

As the object of the investigation and report is necessarily divided into two principal features—(a) an allocation of and the amount of wastes in labor, fuel and other materials as at present applied to the railways and industries in the zone, and (b) the design of a regional system by the means of which these wastes will be eliminated—it seemed of special importance to me that the investigation should be divided into three departments—(1) power and transmission, (2) railways, and (3) industries. To that end three departments were created and a division chief appointed to head each, with an engineer-secretary assigned to the duty of collaborating with these division chiefs in the collection of field data and preparing the data as nearly as possible for report text. The services of the Chief Hydraulic Engineer of the United States Geological Survey and of the Chief Mechanical Engineer of the Bureau of Mines will also be contributed in part to the engineering staff of the superpower survey.

Feeling the desirability of obtaining the counsel of men who would be representative of power producers and power consumers and of the people as a whole representing a national power policy, I recommended to Director Smith, of the United States Geological Survey, that an advisory board be appointed of men representative of the above classes, and to that end the Secretary of the Interior officially invited to membership on such a board gentlemen who would be representative of New England railroads, New York railroads, engineering, technical publicity, the National Electric Light Association, the American Electric Railway Association, the American Railway Association, and the National Industrial Conference Board.

Meetings of the Advisory Board, which will be attended also by the Director of the United States Geological Survey and the chairman of the Engineering Staff, will be called not less than every two months, at which time the chairman of the Engineering Staff will present the progress of the work during the two previous months and the proposed procedure during the succeeding two months. In such manner the engineering staff will constantly have the advantage and value of the counsel of such an advisory board. Professor L. P Breckenridge, of Yale University, has consented to serve as chairman of that board.

Filing Magazine Articles

A useful method of filing articles from technical magazines is described by J. B. Dillon in Power Plant Engineering:

The steel wire clasp that binds the magazine is removed with a pair of pliers and a knife. This permits spreading out the pages single, or double; using a paper knife as desired. Next the preferred pages are placed in a loose-leaf binder. With a blue pencil each page is numbered from 1 up. In the back of the binder are 23 sheets of unruled white paper the same size as the clippings. These sheets, headed A, B, C, etc., X Y Z on one sheet and are used for indexing the articles. For example on index page A will be found Alternators in Parallel 666. Alternator Slip 544. Now under S is also shown Slip 544. On index page B is Belt Slippage, cause, 272, and so on all through the alphabet. Any small item that is of importance is not cut and carried in an envelope, pigeonhole, or any other place, but the whole page is placed in the binder, the item properly listed in the index and can be brought into view within a minute; the only search necessary is to scan the index and then turn a few pages. Should the original item not carry a caption, it is easy to give it one with your blue pencil and so list it in the index.

The Unit Freight Handling System

The River and Rail Transportation [illegible] has developed the [illegible] Freight Unit [illegible] container designed to carry freight [illegible] to facilitate its transfer. As described in the Railway [illegible] these containers are made in a [illegible] different ways for carrying [illegible] kinds of materials, with side opening doors for package freight, with [illegible] and dump bottoms for loose bulk freight and tanks for [illegible] liquids. They are designed so that merchandise [illegible] placed in a container at a manufacturing plant [illegible] the container locked and sealed and then transported by motor truck to a railroad car or to a [illegible] the container and its contents are transferred [illegible] without rehandling the material and without incurring the risk of loss so frequently resulting through theft or from the damage occurring in the more common methods of handling freight.

The units are made in capacities of 2½ tons and [illegible] each and are proportioned so that [illegible] units or [illegible] 2½ ton units or several units of both [illegible] and for any of the different classes of freight can be carried on a flat car of [illegible] tons capacity. They are rectangular in form and are substantially constructed of steel plate rigidly reinforced with angle irons to withstand the strains due to the weight of the contents and the transferring of the unit from one vehicle to another.

The complex freight handling equipment as developed by this company includes a specially constructed flat car. This car, however, differs from the ordinary type of flat car now in use on the railroads of the United States only in having provision made for clamping the containers to the car so that they will withstand the shock incident to train movement. These special cars may be constructed at practically the same cost as any other type of flat car. At a small cost, any flat car built in the usual way may be altered so that the containers can be secured to it or in an emergency they can be secured by using side stakes.

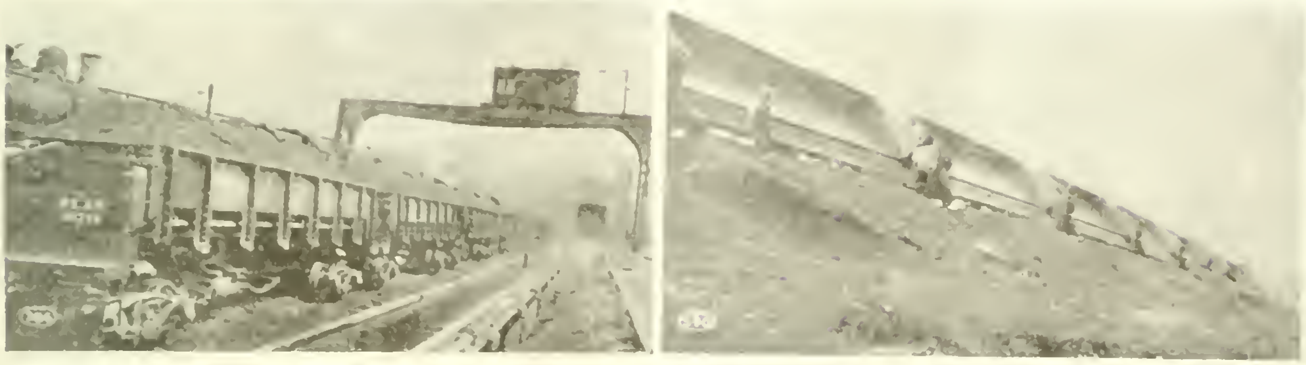
Those containers designed for package freight are provided with side opening doors on two sides through which they are loaded or unloaded. This type of container is fitted with steel cables, attached to lugs at the top corners, by means of which it is lifted and placed on, or taken off of the truck, car or boat. To lift the entire unit a crane, derrick, or other lifting device is required and such equipment generally is installed in large freight houses, or yards, and at terminals. When such equipment is not available a portable crane of the motor truck type may be used. Therefore it is generally possible to handle the loaded container, but when, at small manufacturing plants, or at outlying freight houses, this can not be done, due to lack of facilities, the car on which the containers are placed may be run alongside a platform and the freight loaded in the same manner as in an ordinary box car.

The United States Railroad Administration adopted this system to facilitate water-rail shipment of war supplies. Twenty of the 10-ton package units were built and are said to have given very satisfactory service in the New Orleans district in handling package freight.

In later improved designs containers for handling loose bulk materials were equipped with ladders, handholds and [illegible] through which the freight is [illegible] discharge [illegible] of an [illegible] handling loose materials. [illegible] the doors are closed and [illegible] by means of [illegible] from a spreader bar [illegible] to the sides of the [illegible] position by means of [illegible]. When the container is in the desired position [illegible] and the container [illegible] released [illegible] the [illegible] and discharged.

Economical Handling of Railway Waste Material

[illegible] the [illegible] which they handle [illegible] from power houses and [illegible] the way of its [illegible]



Clark Dump Cars Handling Ashes From Scranton Engine Terminal of Delaware, Lackawanna & Western R. R

The usual practice in handling these materials is to load them into such gondolas and hoppers as are available and ship to place of disposal. The loading is usually done by modern mechanical means. In the steel plants granulated slag runs into the cars from chutes, and heavier slag is loaded by overhead gantry cranes. Engine terminals are often equipped for mechanical loading. The unloading, however, is a different story.

The cars run to the dump in a step by step process through yards. In cold weather the material freezes; sometimes in a solid mass. Arrived at the dump it is unloaded by labor at such a speed as the available labor supply will permit. A locomotive crane and grab bucket are frequently used, but even then labor has to finish the job. In winter this job is very difficult. At best the crane and grab bucket are hard on the cars, pounding the floors and sides, but in winter dynamite is often used to break up the loads with results easily imagined as to its effect on the cars.

Several railroads have recently broken away from the practice noted above and are now handling waste materials in specially constructed side dumping cars. The Delaware, Lackawanna & Western R. R. for instance, by using these cars, effected a saving of $100,800 in one year in the labor cost of unloading ashes from one engine terminal at Scranton.

On the Lackawanna the average cost of unloading ashes by hand over a period of one year was 65 ct. per cubic yard, or $28 per car of average loading. The engine terminal at Scranton produces 10 carloads of ashes every day, which gives an unloading cost of $280 per day, $8,400 per month, $100,800 per year. The railway put 10 dump cars at this place. The ten cars cost less than $60,000 and require absolutely no labor for their unloading. Moreover, they are built to dump material and their unloading therefore does not produce any damage to the equipment. They are taken out to the dump, dumped and returned without disconnection from the engine. This quick return for reloading means that the ten cars completely care for the ashes at this place where 40 cars were used by the old method.

A. A. E. Water Power and Conservation Committee. The Board of Directors of the American [illegible] Engineers has appointed a Committee on Water [illegible] and Conservation, headed by Doctor F. H. Newell. [illegible] members of the committee are Edmund T. Perkins, president of the Edmund T. Perkins Engineering Co. of [illegible]; Charles E. Waddell, consulting engineer of [illegible], N. C.; L. F. Harza, hydroelectric engineer of [illegible]; [illegible] A. Allen, consulting engineer of Chicago, and [illegible] of Los Angeles.

News Letter

ST. LOUIS ITEMS

By A. B. K[illegible]

[illegible] construction [illegible] M. K. & T. Ry. [illegible] Mo. They [illegible] their Webster [illegible].

[illegible] construction [illegible] flood protection [illegible] future floods [illegible] F. N. J[illegible], with offices [illegible] Bldg., S[illegible], has been re[illegible] Board of Commissioners [illegible] Flood Control [illegible]. [illegible] will [illegible] conditions, pre[illegible] in the [illegible].

[illegible] Construction Co. [illegible] Dak., have a [illegible] that they would [illegible] work by spring.

The new St. Louis Locomotive and Car Co., recently organized [illegible] with [illegible],000, completed [illegible]man-Kohl tract [illegible] on the East Side, [illegible] of the Free Bridge [illegible] to erect a plant [illegible] and rebuild locomotives and railroad cars. Rob[illegible] of Chicago, president of the company, said the [illegible] will employ [illegible] workmen.

[illegible] formerly with McCabe & Steen, was a visitor here [illegible] while the writer was on a [illegible] trip. Sorry we [illegible] but call again soon. Yates is now connected with [illegible] engineer's office of the U. P. R. R. in Omaha.

[illegible] Catty, [illegible] West Park [illegible], St. Louis, Mo., has 3 [illegible] to place on [illegible] work in this neighborhood.

[illegible] of concrete road, part of the Old National Trails road between Collinsville and East St. Louis, was thrown open to the public on Dec. 1st. The work which cost $150,000 was done [illegible] supervision of S. F. Wilson, directed by Charles M. Slaymaker, district engineer of the Illinois State Department of Highways. The road is 18 feet wide. This will make the Collinsville road serviceable for this season. Early next season it is planned [illegible] under the railroad tracks at Ninth street and the Collinsville road, East St. Louis, and to pave the macadam road, which leads into the city of Collinsville. The completed road [illegible] the Indian Mound district, which may be purchased for a state or national park. Chief of these mounds is the Cahokia Mound which was visited by a number of the Indians who attended the recent conference in St. Louis.

A. H. W[illegible], 1400 Taylor street, Amarillo, Texas, has about [illegible] work at that place and is in the market for some more grading. [illegible] southwest Texas or eastern New Mexico.

[illegible] Matsen, Inc., have finished their State road work across the river here. Have 60 mules and 2 revolving shovels idle that they can put on work immediately. 1307 Wrightwood avenue, Chicago, Ill., will catch them.

McNamee Bros. have discontinued work for the winter on their State Road job over in Illinois. Will resume operations as soon as weather permits next spring.

D. A. McLaughlin, a good all around railroad superintendent or foreman, is idle at De Witt, Mo.

C. R. Cummins Co. of Cleveland and St. Louis got in on a [illegible] coal stripping job near Oakland City, Ind. P. J. Watson, who is looking after their interest here, is going to be in charge of the work. Paul Grafe will be transferred from Cleveland to St. Louis to succeed Watson. Mr. Dern will continue to be in charge [illegible] the office in the Railway Exchange Bldg. here.

Argalus Stubbs of Edwardsville, Highway Commissioner, on Dec. [illegible] ordered the closing of the Alton road at Cahokia Creek for [illegible] several weeks until the completion of a bridge over the [illegible] the creek. An excavator building the new channel [illegible] cut the bridge at this point in the road. St. Louis contractors are at present putting in foundations and doing other preliminary work for the several bridges that will span the creek.

[illegible] & Horner are doing the pile driving for the bridge [illegible] for the state road near Carbondale, Ill. [illegible] & Horner have two more pile driver outfits idle. Their [illegible] 217 [illegible] avenue, St. Louis, Mo.

The Kansas City Bridge Co. were awarded the contract by the [illegible] Horners Lake and filling up cribs with rock at the Chain of Rocks for the water department here. Geo. Mait[illegible] of the company was in the city the other day and arranged [illegible] delivery of 10,000 yd. of riprap by local quarries for this job.

E. L. Brandt, formerly with the American Bridge Co., has been [illegible] permanent district secretary of the American Association [illegible] according to announcement by E. Paffrath, president of the St. Louis Chapter. Brandt has arrived here and will [illegible] in a few days.

[illegible] expects to finish the [illegible] part of his road work [illegible] in a few weeks. Will do the light work and [illegible] spring.

Contractors when in want of labor or work for their outfits write [illegible] Labor Agency, 612 Walnut street, St. Louis, Mo., 503 Delaware street, Kansas City, Mo., or 1020 Douglas street, Omaha, Neb.

[illegible] has finished a piece of double track work on the [illegible] R. R. between Roodhouse and Manchester, Ill. [illegible] Bros.

[illegible] S. [illegible], the boss station man whom we reported [illegible] a sore foot in last [illegible] is up and around again [illegible] station job in southern Illinois the first day of [illegible].

[illegible] in Madison County, Illinois, organized the [illegible] Levee District. The plan is to make a new [illegible] Wood River and build levees to restrain the [illegible] about 1000 acres of land in [illegible].

[illegible] L. J. Smith Construction Co. have 20 miles graded and [illegible] track laying on the Uvalda & Northern R. R. in Texas. Will have another 26 miles graded and ready for steel within 30 [illegible]. This company is also piling up some big estimates on their [illegible] jobs on the White River branch of the Missouri [illegible] R. R. in southern Missouri and northwestern Arkansas.

C. W. King, of P. W. King & Co., who are handling the boarding outfits for the Buffalo, Rochester & Pittsburgh Ry., was with us a [illegible] last week. King reports a splendid business in the east [illegible] the past year. Slowing down a little now.

The recently elected East Side Levee and Sanitary District [illegible] for organization Dec. 6 in the offices of the board, 225 [illegible] avenue, East St. Louis, and elected Martin D. Baker [illegible]. No appointments were made. The next meeting will [illegible] Saturday afternoon. All members of the board—William [illegible], Albert E. Meints, Henry S. Kramer and Martin D. Baker of East St. Louis and Robert Schmidt of Granite City—were present. All are republicans except Kramer.

T. J. Morris has his outfit at work on state roads in southern Illinois.

Personals

P. B. McDonald of New York University is editing a book on [illegible] heating for Warren Webster & Co.

E. G. Lane has been appointed engineer of maintenance of way of Baltimore & Ohio R. R., eastern lines, headquarters at Baltimore, Md., vice S. A. Jordan, transferred.

A. B. Smith, of Pasadena, Calif., has resigned as assistant engineer in the office of J. W. Reagan, chief engineer of the Los Angeles County (Calif.) Flood Control District, and will engage in private practice.

J. N. Thompson, roadmaster of the Pittsburgh, Shawmut & Northern R. R., with headquarters at Angelica, N. Y., has been appointed superintendent, maintenance of way, with the same headquarters. H. L. Newman has been appointed maintenance engineer with headquarters at Angelica, N. Y.

F. C. Hitchcock, for many years vice-president and general manager of MacArthur Bros. Co., contractors, has resigned in order to devote his time to other interests. He has been elected president of Carey, Campbell & Co., a contracting corporation, with its Main office at 96 Wall St., New York City. Mr. Hitchcock is also vice-president of Siems-Carey Railway & Canal Co., and has spent several years in China for that company in connection with its concessions for railroad building there.

Charles J. Vanneman, chief of the division of steam railroads, has been appointed chief of the divisions of steam and electric railroads which have been consolidated by the New York State Public Service Commission of the Second District. Ray G. Winans, assistant inspector of the division of electric railroads, has been appointed chief inspector of electric railroads. Charles R. Barnes, formerly chief of the division of electric railroads, recently resigned to become head of the commission operating the street car lines in Rochester, N. Y.

Obituaries

John Scott, civil engineer, who for several years has taken prominent part in many local and western Canadian railway enterprises, died Dec. 5 at the Corona hotel, Winnipeg, Man., after an illness of little more than an hour.

Edward V. Smith, division superintendent of the Baltimore & Ohio R. R., with headquarters at Wheeling, W. Va., died Dec. 7 of pneumonia. From 1910 to 1914 he was assistant division engineer at Wheeling. He was 48 years old.

Benjamin Holt, president and one of the founders of the Holt Manufacturing Co., died Dec. 5 at his home in Stockton, Calif. Mr. Holt was born in New Hampshire in 1849 and was one of the three Holt Brothers who had been engaged in the manufacture of wagon wheels in New England and who went to California in the early 60's, started a wagon shop in San Francisco and later moved to Stockton. Benjamin Holt was the inventive genius of the organization. He perfected the Holt combined harvester and later, Holt steam traction engines of unique type for mountain and desert work. It was these engines that were used in the earily 90's for pulling gangs of plows in the valleys of California. From the necessity of providing a surer traction for soft soils, Benjamin Holt gave the world his invention, the track-laying type of tractor, bearing his name.

George S. Rice, formerly chief engineer of the Boston Transit Commission, died Dec. 7 at his home in Montclair, N. J., after an illness of several months. He was graduated from the engineering department of Harvard in 1870. Later he worked for several months in the engineering department of the Boston Water Works on the construction of Chestnut Hill reservoir. He then became assistant engineer of Lowell Water Works and Boston Water Works. For seven years, beginning in 1880, he was mining in Arizona. He then became deputy chief engineer of the Aqueduct Commission in New York. About 25 years ago he became chief engineer of the Boston Transit Commission. At that time he had a private business here, in partnership with George A. Evans, and taught engineering at Harvard. In 1905 he became chief engineer of the New York subway. For 12 years ending last year he was division engineer for the New York Public Service Commission.

Industrial Notes

The Oxweld Acetylene Co. announces the appointment of the Standard Supply & Equipment Co., of New York and Philadelphia, as eastern sales agent for Eveready welding and cutting apparatus and supplies. The company has appointed as manager of its welding and cutting department George E. Temple, for six years connected with the Prest-O-Lite Co., which formerly manufactured and marketed the apparatus now known as "Eveready."

The Chicago Bridge & Iron Works has opened a new sales office in the Forsythe building, Atlanta, Ga. Joseph L. Zeller, who has been with this company for quite a few years, will be in charge and will handle the states of Georgia, Alabama, Tennessee and Florida.

Laurance H. Hunt has been appointed manager of the construction department and Major E. Holmes manager of the chemical department of the National Lime Association.

J. C. Kopf, formerly manager of the engineering department of the Duff Manufacturing Co., has been appointed research engineer and placed in charge of a newly established research department. F. W. Schwerin has been promoted to manager of engineering.

Building and Structural Monthly Issue

ENGINEERING AND CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice-President and General Manager*
New York Office: Rm 4[illegible]3 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office, Room 413 Engineers' Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railways, Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company.

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00, any one monthly issue 50c. Extra foreign postage, all issues $4.00, any one monthly issue $1.00.

Volume LIV. CHICAGO, ILL., DECEMBER 22, 1920. Number 25.

Why the "Coal Supply Problem" Should Be Studied by Engineers and Contractors

Aside from our general interest in "the coal supply problem"—an interest that every intelligent American should have—we that are engaged in engineering and contracting should be particularly anxious to understand the nature of this great economic problem and the proposed solutions of it. Besides, we should act collectively to secure legislation that will prevent such a disastrous restriction of construction work as occurred last summer and autumn, because so many open top cars were requisitioned for coal transportation.

The best discussion of this problem that we have yet seen is a paper read before the October convention of the American Electric Railway Association, namely, "Problems of Coal Supply," by Eugene McAuliffe, president of the Union Colliery Co., St. Louis, Mo. The 36-page pamphlet reprint of this paper should be secured by every engineering and contracting society and read at some meeting in the near future. The paper should be discussed, and if the two proposed "senate bills to aid in stabilizing the coal industry" meet the approval of any society, resolutions of approval should be sent to members of both houses of Congress.

The bills provide that:

(1) Freight rates on coal shall be less per ton during the spring and summer than during the fall and winter.

(2) The Secretary of the Interior shall investigate (a) living expenses and wages of coal miners, (b) coal storage, (c) coal consumption and the distribution of coal cars, (d) the desirability of a statutory coal zoning system; and shall require coal mine operators and dealers to file periodic statements as to prices, costs, profits, etc.

Mr. McAuliffe is strongly of the belief that coal can not be profitably stored at the mines, but that it should be stored by the users, and that in order to induce such storage there should be a lower freight rate during the months that are now months of reduced coal consumption. He urges this measure not merely to decrease the average cost of producing and hauling coal, but to give the miners continuity of employment. During the past seven years coal miners in America have averaged 231 days worked and 77 days idle per annum. This excessive idleness has bred bad habits, dissatisfaction and frequent strikes.

Mr. McAuliffe believes that a law that will secure nationwide knowledge of the pertinent facts relative to the coal industry will contribute greatly to the stabilization of the coal industry, and to that of all other industries. He points out that 37 per cent of railway ton-mileage is due to the transportation of coal. During the year 1918 the tonnage (2,000-lb. tons) produced in America was as follows for our leading raw products other than cotton, lumber and animal products:

Coal	
Anthracite	98,826,084
Bituminous	579,385,820
Total coal	678,211,904
Metals.	
Steel	49,797,923
Copper	999,267
Lead	539,686
Zinc	492,405
Total	51,829,281
Farm Products	
Corn	90,398,490
Wheat	27,813,000
Oats	24,613,744
Potatoes	12,003,180
Barley	6,153,000
Rye	2,194,884
Total	163,176,298

Mr. McAuliffe says:

> We shall never have a steady and adequate coal supply until we get a proper conception of the magnitude of the coal tonnage and lay down a definite program for levelling up the general load on the railroads. * * * Gradually and without violence to established business interests a system of coal market zones should be built up through the medium of rate control. Excessively long and overlapping coal hauls should be penalized; the last two or three hundred miles should bear a prohibitive rate instead of being given away as the carriers have frequently done in the past.

Mr. McAuliffe makes the startling statement that railways prohibit the loading of coal cars except [illegible] day. The ruling was made by the [illegible] Administration of the Australian [illegible] he implies [illegible] properties were being strangled by labor [illegible] and sought to deny double shift [illegible] fields."

This and other references to labor [illegible] worthy of solemn consideration [illegible] restrictions to multiply. America will [illegible] of Great Britain where the [illegible] have completely throttled the coal industry.

Economic Problems Can Not Be Solved by Debate

When a man really knows the answer to an economic question, he submits data that force admission that he knows the answer. When he merely thinks he knows, he resorts to the methods of debate. Occasionally an engineering paper becomes the subject of debate, but when this occurs it may be safely inferred that there is a dearth of data which the debaters are striving to conceal in a plethora of platitudes and bald assertions.

There may be wisdom in a multitude of heads, but it can rarely be used to advantage in solving an economic problem. This not only because the wisdom is rarely sufficiently definite and complete for the given problem, but because a multiplicity of disconnected facts is more apt to confuse than help those that are trying to solve the problem.

Put differently, economic problems are best solved by scientific methods such as engineers commonly use than by debating methods such as lawyers commonly use. This holds as true of problems in political economy as of problems of engineering economics. But so crude is the average conception of the nature of economics, even among educated men, that we are still many years' journey away from a general agreement that economic talk is not merely cheap but worthless unless abundantly sustained by economic facts.

John Stuart Mill is the author of a celebrated treatise on political economy, and, although he is also a celebrated logician, his book on economics is a real mine of fallacies. This is consequent upon his reverence for deductive argument as a means of arriving at truth. He goes so far as to say that politics can never become an experimental science, but must ever remain a deductive science. Starting with a few general principles, such as the superior urgency of the instinct of selfishness, he attempts to arrive by deduction at a code of rules for political administration. He was not the originator of this method, for Adam Smith and other writers had explained much the same theory; but he was perhaps the first to carry the theory to its logical limit and decry the usefulness of experiments in political administration. Once Mill's theory is admitted, the door is thrown open for every conceivable "theory" of government, for if experiment is cast aside as a criterion, only speculation based on questionable experience or on still more questionable hypotheses remains.

To most engineers any such scheme of economic reasoning is repugnant, but as yet few engineers have voiced rebellion against the classical method of solving problems in political economy. The time is over-ripe, however, for outspoken condemnation of debating society methods in politics. Not only do such methods breed glib and careless politicians, but they foster the absurd idea that political economics is a science essentially different from engineering economics. A democracy needs, perhaps above all, to be taught that one able specialist is usually better able to solve any economic problem than a multitude of non-specialists. Democracy needs also to be taught that political questions are, for the most part, problems in economics, and that no economic problem can be solved correctly without quantitative data.

"Is government ownership of railways desirable?" Men may talk till Gabriel blows and never answer the question convincingly until they begin to compare unit costs of railway transportation under private and under government management. Yet many of us remember with what assurance William Jennings Bryan announced two decades ago that a trip to Europe had convinced him that government ownership of railways was desirable for America. Without a scrap of comparative cost data in support of this conclusion, he had [illegible] it all out as a result of seeing government [illegible] in operation in Europe. Such is the debating school [illegible] upon the minds of able men.

Engineers to Light the Way

Engineers have built a machine designed to operate for the public good. Sooner or later it is expected to be widely recognized as built for the purpose stated—the well-being of the country, socially and economically, so far as engineers can serve and not for individual benefit and only remotely for that of the engineering group. As professional men engineers have long taken themselves seriously, but have not felt that the community fully shared this view. There is no gainsaying that great construction projects, industrial legislation and other concerns of modern civilization have been carried to advanced stages with little or no call for the advice of engineers, through their various societies or in any other broad way, even though engineering questions have been involved.

The belief has been growing that engineers should attain recognition through collective action and secure public confidence partly through such means. Thus a reservoir of expert knowledge would be ready for tapping whenever the expediency of proposed legislation affecting industry or of plans for conservation of natural resources is questioned. Accordingly the American Engineering Council has been created. An auspicious start has been made by securing an engineer of international fame for its president—Herbert Hoover. In a word it may be described as a machine of the universal order, in machine shop parlance, capable of performing several operations. Precisely what it is to do is as yet somewhat vague, most of the effort having been directed, rightly no doubt, to perfecting the mechanism. It remains that this super-organization, composed of representatives of engineering associations all over the country, must take the inititive in showing its capacity for public service, looking to the time when its counsel will be sought by governmental and other public agencies. Publicity is to be its watchword and the press will be freely supplied with the findings of committees through which much of the work doubtless will be done.

What the council cannot yet claim is that it represents most of the engineers of the country. Conspicuous among the associations which have not affiliated is the American Society of Civil Engineers, and the movement thus far lacks the numerically strong American Association of Engineers. However, with the support of 10 more organizations that now actively consider joining, the council will be in the position of speaking officially for half the great body of American engineers. What is of chief importance is that through its member-societies it has the call on engineers of acknowledged pre-eminence. Its influence on that account will make its numerical basis of secondary account, no matter to what size it may grow.

The period of putting the new machine into action will be the test. If the determination of the front rank engineers who have labored to build it is a criterion of its ability to perform, then those societies now looking on will wish to be partners in the enterprise. Fear of failure and the cost of running the machine have their influence in delaying decisions; but if the fear is proved baseless and the cost is found to be no real bar, it cannot be that the associations absent from the council table will long remain aloof, so lofty is the aim of the new organization and so large its promise of good.

—Editorial in the Iron Age.

New Directory and Market Data Book.—Crain's Market Data Book and Directory of Class, Trade and Technical Papers, now on the press, promises to be of unusual interest to advertisers generally and users of trade and technical papeers in particular. It not only lists all of the business publications of the United States and Canada, giving circulations, rates, type page sizes, closing dates, etc., but supplies a market analysis of each trade, profession and industry. Thus the reader is given the basic facts of each line in which he may be interested, including its buying power, buying methods, character of requirements, etc. The volume, which is bound in cloth and contains nearly 500 pages, is published by G. D. Crain, Jr., 417 S. Dearborn St., Chicago.

The Federal Building Loan Bank Bill an Aid to America's Industrial Housing Problem

By LEONARD S. SMITH,

Professor of [illegible] University of [illegible]

America's housing problem is a challenge to our intelligence, to our patriotism and to our idealism. America's industrial housing problem in addition to all these is a challenge to the sound business judgement of our captains of industry. The compelling considerations which demand a solution of the problem and that promptly, rest perhaps quite as much upon social values as upon immediate and pressing needs of industry for labor. In fact we are beginning to see that if such social needs, as decent housing are supplied both sufficiency and efficiency are insured and the cost of production thereby reduced. Thus both economic and social needs are met by adequate home building.

Housing Standards.—Until very recent times, houses were very rarely built for workmen, and in the few cases where houses were built for this class, they were woefully deficient in the requirements demanded by American standards of living. In the great majority of cities examination shows that workmen occupy rented houses built for and occupied for many years by a richer class. When, however, the houses became too old and unsanitary or the neighborhood lost its character, due to its invasion by offensive business or industry, the former owners moved to better houses in more protected neighborhoods, and the less exacting workman families took their places. High land values and poor city transportation quickly crowded such land with houses and then crowded the houses with people creating the well known city slum. Such shameful housing conditions in all stages of completion may be found in nearly every American city. If the many century old cities of Europe must be cursed with such slums, there certainly is no reason why they should be permitted to grow here where most cities are less than 100 years old.

The war has greatly hastened housing reform by quickening the peoples' conscience to general community needs and responsibilities, by permanently raising the standard of wages, and by raising the standards of industrial housing. Then, too, the high standards shown in the government's war housing (including 6,000 workingmen's homes in 30 different communities) have set the pace for future builders. Manufacturers are quite generally coming to act on the knowledge that the housing of the human machine is at least of equal importance to the success of their business, as the housing of their steel machines. Because a happy and contented labor supply is of first importance to the factory's output, a considerable portion of the company's capital must be invested in housing its labor. Whether such houses shall be sold to employes or rented to them must depend upon local conditions, but speaking generally men who own their homes are most apt to take an interest in the community welfare and prove better citizens. On the other hand, we must not lose sight of the fact that home ownership has operated in the past to tie the workman to his job, sometimes to his disadvantage.

The greatest menace which England faces today from its working classes is closely connected with the English system of land tenure which allows 2,500 persons to own half, and 40,000 to own about 80 per cent of all England's soil. Englishmen are in fact a nation of renters, a condition which today furnishes much discontent, and menaces the nation's future.

United States is fast becoming a nation of renters also and hence the supreme importance of home building and home owning at the present time. In 1890, 48 per cent of our people owned their homes, while in 1910 the proportion was 45 and today is estimated at 42 per cent. A similar decline in rural ownership has also resulted, viz., from 66 per cent in 1890 to 59 per cent today. A very large portion of the owned homes, in the New England and North Central States over one-half, are encumbered with mortgages. This failure to own a home is especially true of the cities where from three-fifths to four-fifths of the homes are rented ones. It is here, too, that we find the greatest unrest and radicalism which many believe threatens our free institutions.

While such conditions are serious enough, they by no means complete our housing problem. At a time when weddings continue at the rate [illegible] per year and after [illegible] year cessation of building [illegible] accumulated deficiency of over a million homes [illegible] houses.

The main cause of [illegible] condition [illegible] lack of material or labor but [illegible] which make it extremely difficult to [illegible] be described only as a [illegible] help. It is no time for old time [illegible].

One of the plans which [illegible] building funds is the proposed Federal Building Loan Bank Bill known as S 2492 introduced in Congress in October, 1919.

The Federal Building Loan Act (Calder Bill).—In view of the important bearing of the bill on our national housing situation it deserves the widest publicity. The merits of the bill are so evident and so important that they need only to be widely known to insure the passage of the bill into law. The bill simply greatly extends the usefulness of our 7,184 building loan associations by making immediately available for home building about $1,000,000,000 of the assets of these associations, now securely locked up in the form of mortgages and now serving no useful purpose. It calls for no appropriation of public funds but instead simply improves a system of home making that has stood every test in England and America for over 200 years.

A public hearing on the bill was held Oct. 8, 1919, which developed no objections. The bill is entitled, "A bill to encourage home ownership and to stimulate the buying and building of homes; to create a standard form of investment based on building association mortgages; to create government depositories and financial agents for the United States; to furnish a market for government bonds and for other purposes."

Definitions in the Bill.—The bill defines the term "building loan association" so as to include incorporated building and loan associations, savings and loan associations, co-operative banks, homestead aid and other kindred associations organized and conducted exclusively for the mutual benefit of their members and doing what is generally known as a co-operative building and loan association business but subject to supervision and examination by state authority. By the term first mortgages as used in this bill is included such classes of first liens on real estate, not exceeding $6,000 in amount in any case, as are given to secure advances made by building loan associations under state law and when approved by the superintendent of Federal building loan banks.

Purpose of Act.—The act provides that to enlarge the facilities for the purchase and erection of dwelling houses by wage workers and others there shall be established in the department of the Treasury a bureau relating to the establishment and maintenance of mutual and co-operative Federal building loan banks under the charge of a superintendent appointed by the President, who shall hold office for a term of five years unless removed for cause.

The superintendent is directed to divide the United States into 11 Federal building-loan bank districts, and to organize such a bank whenever there may be 10 building loan associations with aggregate assets of not less than $5,000,000. Each of such banks shall begin business with a paid-in cash capital of not less than $100,000 in shares of $1,000 each, purchasable only by building-loan associations upon application to a Federal building-loan registrar to be appointed by the superintendent in each Federal building-loan bank district.

Issue of Bonds.—Such building loan banks are directed to sell Federal building-loan bonds at not less than par and to receive and deposit in trust with the Federal building loan registrar of the district first mortgages given to and owned by any member of such bank; such mortgages to be held by the registrar as collateral security for its Federal building-loan bonds.

Any Federal building-loan bank shall designate some bank of the Federal reserve system as depository of its current funds subject to check and besides the usual powers and duties of other banks the Federal building-loan bank is empowered to borrow money for temporary loan (90 days) to building-loan associations, but only upon notes which shall be taken up and paid by said association out of the proceeds of the sale of the bonds issued for such associations.

Any Federal building-loan bank may loan up to 10 per cent of its funds representing its capital stock to its member association, and likewise may loan from funds arising from the sale of Federal building-loan bonds and shall receive for such services in addition to interest charge a commission not exceeding ½ of 1 per cent per annum upon the balance due from such member association to such Federal building-loan bank. The rate of bond interest is limited to 4½ per cent.

Limitation of Power.—Such banks may be designated by the Secretary of the Treasury as government depositaries to receive public funds, but such Federal building-loan banks shall not have the power.

(a) To accept deposits of current funds or to do any banking not expressly authorized by this act.

(b) To accept any mortgages on real estate except first mortgages deposited by building associations as collateral or

(c) To issue Federal building-loan bonds in excess of 20 times the amount of its outstanding capital or to advance funds to any member to an amount exceeding 20 times the amount of its capital stock owned by such member.

Safeguards.—Each member association shall be the owner of at least one share of capital stock of the Federal building-loan bank ($1,000) and all subscriptions shall be made at par and in gross amount must not exceed 10 per cent of the assets of such member.

Any member association desiring a loan shall file an application to the Federal building-loan bank giving the amount needed with a list and description of first mortgages, the amounts then due, the size and character of the house erected thereon with the appraised value of the property. The aggregate unpaid balances of house mortgages taken to secure a loan shall be at least 25 per cent in excess of the loan asked for and in no case shall exceed 20 times the par value of stock in the Federal building-loan bank held by such association member. Unpaid balances on any mortgages must not exceed 70 per cent of the appraised value of the property. No member association may incur money obligations through the Federal building-loan bank or otherwise in excess of 60 per cent of all its mortgage assets. As further guarding the security of all Federal building-loan bonds officers of building loan associations are under bond and required to make formal written statements of the principal amount remaining due upon all first mortgages deposited as collateral security and additional mortgages may be required by the Federal building-loan bank if deemed advisable. The building loan associations may withdraw any mortgages and substitute others provided the latter are registered and approved by the Federal registrar.

Guarantee.—At the time any member association assigns its first mortgages to secure an issue of Federal building-loan bonds such association must execute and deliver to the Federal bank an agreement of guarantee to repay to it the actual money advanced in equal semi-annual payments and also to pay semi-annually the accrued interest and commission due from the association to the bank. The association must also guarantee that the amount remaining unpaid on the mortgages assigned to the bank shall at all times be maintained at at least 125 per cent of the sum remaining due upon the principal of all Federal building-loan bonds issued on account of such building loan association.

The guarantee shall also bind the association to keep mortgaged houses insured against fire and to arrange for payment of all fire losses to the mortgagee and its assigns. All such guarantees are to run until all payments of principal, interest and commission have been paid.

Investment of Money.—The amortization and other payments on the principal debt owing by members of the Federal building-loan bank shall constitute a trust fund in the hands of the bank and shall be invested as follows:

(a) To pay off its Federal building-loan bonds as they mature.

(b) To purchase at or below par Federal building-loan bonds issued by such bank or by any other Federal building-loan bank.

(c) To purchase U. S. Government bonds or other obligation of the U. S. government.

Reserve and Dividends.—After paying expenses from earnings, Federal building-loan banks semi-annually shall carry to reserve account 5 per cent of its net earnings until such account equals 10 per cent of its outstanding capital stock. Earnings over and above sufficient to maintain such 10 per cent reserve may be distributed as stock dividends or held as undivided profits. All reserve and undivided profits shall be invested in accordance with rules and regulations to be prescribed by the superintendent of Federal building-loan banks.

Tax Exemption.—The most fundamental provision in the proposed Federal building-loan law is in Section 29, which provides that the capital and reserve of such bank as well as all income derived therefrom shall be exempt from Federal, State or local taxation, except taxation upon real estate purchased and held under the provisions of the act. The bonds of such Federal building-loan banks are considered instrumentalities of the U. S. government and as such are exempt from taxation.

Building loan associations are even under present laws exempt from taxation in several states, including Wisconsin, Michigan, Virginia and New York, on the theory that they are inculcating habits of thrift, frugality and saving, qualities never so important as at the present time. But even a better reason for such exemption is found in the fact that every time a building loan association makes possible a new home, it thereby creates new taxable property from which tax burdens may be collected far in excess of any taxes assessable to building loan investments. Building loan assets can be invested only in home building and home owning; in fact, the activities of such associations must always be the creation of new taxable property.

A precedent for such an exemption is also found in the recent Federal Farm Loan Bank law which relieves from taxation both bonds and incomes derived therefrom when invested in buying or improving a farm. This law was passed to help change farm renters into farm owners, a change greatly needed and ultimately in the interest of all. It has greatly assisted the tillers of the soil and will to some extent check the movement from farm to city. This result is in the interest of all city folk as well because certain to increase the production of both food and clothing and thereby reduce the cost of living.

Tax Exemption and Future Housing.—In the public hearings on this bill recently held in Chicago and other large cities, the main objection centered on the provision for exemption from state and Federal income tax. It was argued that this would affect mortgages on existing as well as future buildings and that the large loss of revenue must be made up elsewhere. New buildings erected at pre-war prices are already most favorably situated with reference to capital invested, and readily rent at prices which assure a satisfactory return to owners. It has therefore been proposed* that the tax exemption clause should be restricted to future housing, but to them only for a term of, say, 10 years. This would give relief where it is most needed and most important of all, it would greatly stimulate new building.

The exemption from tax for 10 years would about equal the depreciation from present prices which may be expected after a few years. If tariff taxes may be imposed to protect an infant industry or if imported articles may be put on the free list in order to increase the supply and lower prices, it would seem that the tax on vitally needed homes may temporarily be waived in order that America may save its moral and physical health.

3,000,000 Houses Must Be Built in Next 5 Years.—We must not lose sight of the fact that we are facing a crisis quite as serious as prompted the recent exemption of ship-building from the Federal excess profit tax. At that time our greatest need was ships, but now we face the even more urgent need of houses. The nation needs at the present time about 2,000,000 new homes, but house-building has come almost to a standstill. It is no longer profitable to build and especially is this so of the type known as workmen's homes. We hear a general complaint of unrest, labor turnover and inefficiency of labor at the present time, but the causes are not difficult to find, and one of them most certainly is the lack of decent homes—in fact, the lack of any kind of a home. The housing problem is the greatest world problem of today. Other nations realize its importance and are taking active steps to relieve the pressure, but in America we only talk about relieving the situation and do nothing instead of adopting new and adequate methods of dealing with the problem. We are too conservative. The plain fact is that we must build about 3,000,000 houses in the next five years. If the old commercial and speculative builders will not invest their labor and money in houses, some other method, some other agency must be secured in order that we may get the homes. The main difficulty to be overcome is to secure the funds. The writer believes that the prompt passage of bill S2492, which has now been before Congress for over a year, will go far toward providing the fund for home building. It contains no new principle of legislation; it requires for its inauguration

*City Club of New York.

and continuance no appropriations of public money; it simply makes available to 7,484 building-loan associations with a membership exceeding 4,000,000 and owning assets of approximately $2,000,000,000, the carefully guarded right to use 60 per cent of their first mortgages (now lying useless in safety boxes) as collateral security for borrowing money to be used in building greatly needed homes for our people. (Not exceeding $10,000 each.)

Our national banks may oppose the bill, but it is difficult to see why they should. Under the old Federal law they are forbidden to make mortgage loans at all and under the Federal Reserve Bank Law the power to make mortgage loans is very limited. At the present time both national and state banks find it much more profitable to discount commercial paper at high rates than to bother with long time amortizing real estate loans.

Bank deposits are subject to withdrawal on short notice and it would be poor business policy to invest such funds in long-time securities; moreover such long time securities are much less profitable than those of short period.

Building loan associations stand on an entirely different footing, for they have no demand liabilities whatever. They are organized as saving institutions wherein members deposit their savings with the idea of allowing them to accumulate for several years. Withdrawals can be paid only from funds accumulated from deposits, hence such associations can safely loan money on long-time amortization plans.

The present bill specifically prohibits the proposed building loan banks from accepting deposits of current funds or from transacting any banking or other business not expressly authorized by this act. Therefore the new building loan bank could not compete with the present banking system for any business considered profitable in the past. The proposed law would allow our present building loan associations to extend their aid to home building at the present time to the extent of over $1,000,000,000. This would make possible 200,000 new homes giving shelter and protection to about 1,000,000 homeless people. Certainly this is worth while and should receive our enthusiastic support. The home is the unit of society; good homes rather than armies guarantee the nation's security and the permanence of democracy.

Upward Water Pressure on Lock Floor

Observations on upward water pressure on the floor of a lock, made last year at Lock No. 43, Ohio River, agree with theory as applied to the design of locks and drydocks on porous foundations, according to an article by Malcolm Elliott, U. S. Assistant Engineer, in the December Military Engineer. Lock No. 43 is built on a porous foundation, the material being a mixture of firm sand and gravel reasonably free from silt. The concrete lock walls and floor are supported by piles. Rows of sheet piling surround the area inclosed by the lock walls and miter sills. As a result of observations Mr. Elliott concludes that sheet piling has little, if any, effect in reducing the pressure if vents are not used, but probably cuts off considerable pressure and flow into the lock when vents are used. With this particular foundation the effect of a vent is felt at a distance of over 200 ft., indicating that the number of holes need not be large. For a less permeable material perhaps closer spacing of holes would be required. It is advisable, however, to use no more relief holes than the number required to relieve the pressure, because a surplus of holes increases the amount of water entering the lock and adds to the expense of pumping.

A. A. E. Committee to Study Bills for Public Works Department.—A committee of seven engineers has been authorized by the American Association of Engineers for studying and reporting on the various bills presented for a department of public works. The members of the committee selected are: George W. Hand, assistant to the president of the Chicago & Northwestern Railway, Chicago; Morris Bien, assistant director of the United States reclamation Service, Washington, D. C.; W. L. Benham, consulting engineer, Kansas City; A. N. Johnson, dean of engineering in the University of Maryland, College Park, Md.; Doctor Frederick H. Newell; W. A. E. Doying, chief inspecting engineer of the Panama Canal, Washington; and Dr. A. D. Morehouse, consulting engineer, Washington.

Code of Practice and Schedule of Fees for Structural Engineers

A proposed code of practice and a schedule of charges for the use of members of the Structural Engineers' Association of Illinois has been prepared by a committee consisting of Hugo Filippi, chairman, H. R. Bradley, I. F. Stern, J. N. Hatch and E. A. Rossiter. The code and schedule have been submitted to the members for discussion and action on their adoption will be taken at the next meeting of the association.

The proposed code of practice is as follows:

Proposed Code of Practice.

In his relation to the client or to the public, the structural engineer should carefully preserve and maintain the responsibility and trust which has been reposed in him, ever bearing in mind that a violation of responsibility or trust manifests itself not only as a discredit to him but casts serious reflection upon the entire profession.

In the relations between the structural engineer and a client, the engineer should be careful to so regulate his conduct as to preserve the dignity befitting the profession. Judgment should be reserved in all cases where a hasty, partially considered decision might result in loss to the client or reflect upon the engineer's professional ability. Acting in a judicial capacity between the client and a second party, he should act with the strictest impartiality, basing his final decision upon the true merits of the case, and under no circumstances should he permit any personal interests, either his own or those of his client, to influence his decision.

The profession of the structural engineer comprises undertakings of great responsibility, involving the welfare and safety of the public. The structural engineer is one whom the public may accept as eminently qualified to take this responsibility, and he should so establish himself as to preserve and maintain all that is implied by the Engineering Act. [Illinois state law for licensing structural engineers.—Editor.]

Code of Practice.—The following principles have been formulated for the purpose of establishing a standard to which all structural engineers can conform. A uniform observance of these principles is required to the end that no particular structural engineer or group of structural engineers shall profit by virtue of special privilege, but rather, having placed all structural engineers on a common basis, the success or failure of each will be determined solely by his professional ability and business acumen.

Professional Relations.—The relation between structural engineers should be one of strictest co-operation. No structural engineer should unjustly condemn the professional work or acts of another structural engineer, and any such unjust condemnation or criticism by a member of this association will render such a member liable to suspension from membership on the grounds of unprofessional conduct.

Expert Evidence.—Where a structural engineer has been engaged as an expert witness, he shall confine his testimony, so far as practicable, to the necessary exposition of facts, figures or engineering theory, as will permit the court or the jury to reach a fair and equitable decision.

Participation in Public Affairs.—This association puts itself on record as being heartily in favor of an active participation by its members in all public affairs, particularly those related to engineering.

The association believes that the tendency on the part of the municipality, the state and the government, of naming laymen only, on committees whose duty it is to investigate and report on matters of a technical or quasi technical nature should be so modified that at least a majority in the membership of such committees will consist of engineers.

The association asks its members to assist in the general dissemination of this principle and to spare no effort in securing this end.

Advertising.—This association stands committed to the belief that advertising, particularly in the form of business cards in technical magazines, is proper, and strictly professional, and that to discourage the same would be in direct contravention of good business principles. The structural engineer is urged to place suitable signs or placards on all structures, the design or construction of which are under his direction, and he should not hesitate to secure publicity in the press if the nature of his work justifies such a step.

He should, however, be careful to see that whatever press publicity he accepts is of an impersonal [illegible], carefully barring all false claims or representations.

The association is not in favor of soliciting business through the medium of circulars of a personal advertising nature and [illegible] all of its members to refrain from this form of advertising.

Competition. Members of this association are encouraged to enter competitions in a manner consistent with the schedule of fees, particularly in the design of commercial buildings. In this way the profession will be greatly benefited and good design attained.

No member of this association may collectively or personally enter into or become a part of any ring or clique, whose object it is to impair the honesty of any competition. A member of this association found guilty of such practice will be dismissed from membership on the grounds of unprofessional conduct.

A member of this association may not knowingly attempt to obtain any professional engagement already under negotiation, or in the possession of another structural engineer, except by the specific invitation of the client, and then only after ascertaining that there is good and sufficient reason for making the change.

Unfair Compensation. A member of this association may accept compensation for service from one interested party only, except it be known that more than one party is involved, when additional compensation may be accepted, providing all parties interested agree thereto.

No member of this association may receive, directly or indirectly any royalty, gratuity or special fee, on any patented article or process used in the work upon which he is retained without the consent of his client.

Co-operation. All members of this association are urged, so far as circumstances will permit, to assist fellow structural engineers, by the exchange of general information and valuable experience, or by instruction through the engineering societies, the schools of applied science and the technical press.

Copyrights. Copyrighting of plans, designs and specifications, with or without supporting design data, is strongly recommended by this association, and all members are urged to protect their work in this manner.

Schedule of Fees.

The proposed schedule of fees, representing the minimum fee to be charged, provides that the charges for professional service may be based upon:

(A) A per diem rate
(B) A retainer fee
(C) A percentage of the cost of the work or
(D) Actual engineering cost plus a fixed fee.

Per Diem Rate. The charge for professional services, for consultations, studies, investigations, reports, and for expert testimony and preparatory work incident to law suits, shall be as follows:

(1) For short engagements on any of the above work, a minimum fee of $100 per day shall be charged.

(2) For preliminary studies, for investigations and for reports, made to determine whether the engineer can support the claims of the client, as for example prior to a law suit, a minimum fee of $50 per day shall be charged.

(3) For submitting a report and reviewing the design prepared by others for existing or proposed work, a minimum fee of $100 per day shall be charged for the first week, $75 per day for the next week, and $50 for each day thereafter until the specified work is completed.

(4) The above charges are intended to cover professional services only, unless otherwise previously agreed to, and any expenses incurred in connection with a specific engagement, such as transportation and subsistence, salaries paid assistants engaged on the work, office and field supplies, and general office expenses shall be charged the client in addition to the above fee.

A Retainer Fee.—(5) Where a member of this association has been retained for general advice by a firm or corporation, and said retainer is for a long term of engagement, he may accept such retainers at a compensation not less than that indicated in paragraphs (1), (2) and (3).

Percentages of the Cost of the Work.—(6) For preliminary examinations, studies and reports on new projects, or for review studies and reports on existing or pending projects previously dealt with by others, a minimum fee of 3 per cent of the cost of the work shall be charged.

Work under this head may be charged for under the terms of paragraphs (1 to 4 both inclusive) if preferable.

(7) For such investigations, plans and specifications as may be necessary to secure an intelligent bid from contractors, a minimum fee of 5½ per cent of the cost of the work shall be charged.

(8) For final working drawings and specifications, together with necessary consultation and general advice during construction, a minimum fee of 7½ per cent of the cost of the work shall be charged.

(9) For professional services, including preparation of final plans, specifications and contract forms, award of contracts, superintendence during construction, testing of materials and general supervision of the work, a minimum fee of 10 per cent of the cost of the work shall be charged.

(10) For professional services incident to engagements involving repairs or alterations to existing buildings or other structures, a fee of not less than 10 per cent of the cost of the work shall be charged.

(11) The percentages indicated in the above paragraphs under this head, shall be construed as applying to work not exceeding $100,000 in cost. The minimum percentage to be applied on larger work shall be as follows:

Paragraphs.	$100,000 to $250,000. Per cent.	$250,000 to $500,000 Per cent.	$500,000 to $1,000,000. Per cent.	$1,000,000 and upward. Per cent
6	2½	2	1½	1
7	5	4½	4	3½
8	7	6½	6	5
9	9	7½	6½	5½
10	9	7½	6½	5½

(12) Paragraphs (6) to (11) both inclusive, are to be computed upon the total cost of the completed work, exclusive of engineering, or upon a bona fide estimated cost or bid pending the completion of the work, with an adjustment when the actual cost is known.

(13) The phrase, "cost of work" as used herein, refers only to such part or parts of the whole work or project for which the engineer has been engaged, clearly excepting, however, all buildings and other similar structures, for which the fee shall apply to the entire cost of the building, not including special machinery, lighting, heating, plumbing or ventilation, unless these items require special consideration by the engineer, in which event the percentages shall be applied whole or in part to any or all of these items as circumstances may direct.

(14) The percentages indicated in paragraphs (6) to (11) both inclusive, include all the charges mentioned in paragraph (4) unless previously otherwise agreed to.

Actual Engineering Cost Plus a Fixed Fee.—(15) a member of this association may accept an engagement on this basis which contemplates a charge to the client to cover the salaries of assistants engaged on the work, and general office expense, with an addition of from 50 per cent to 100 per cent for overhead. In addition to the above, the charge to the client shall be increased for the professional services of the engineer, an amount equal to not less than 50 per cent of the fees indicated in paragraphs (6) to (11) both inclusive.

(16) It is recommended that all members of this association require of the client a written agreement stating clearly and fully the conditions of the engagement, the period during which the work is to be executed, the amount of remuneration to be paid the engineer, and the terms of payment thereof.

(17) Where changes in plans, specifications or contracts are required by the client after work has been commenced thereon, an additional charge may be made against the client, for making such changes at actual cost plus a percentage, as indicated in the first clause of paragraph (15).

(18) In the event that the project covered by an engagement is ordered abandoned upon instructions from the client, the fee which may be claimed by the engineer shall be determined by the progress made, and the expenses and obligations incurred by the engineer.

No recommendation is made to cover this contingency, and all members are urged to reach a fair and equitable agreement with the client without recourse to legal proceedings or arbitration, unless unavoidable.

(19) Where an engagement has been accepted by an engineer with the expectation that an immediate start may be made thereon, and the work is delayed by the client, the engineer may ask for additional remuneration, if proceeding with the delayed work would entail an additional financial burden on him.

(20) Members of this association may enter into competi-

tions providing that the conditions thereof provide for a reasonable compensation to cover the cost of preparing the competitive designs, and that the conditions surrounding the competitions conform to the provisions of the Code of Practice relating thereto.

(21) Drawings, specifications, notes, letters, exhibits, etc., as instruments of service, are the property of the engineer, and shall be returned to him at the conclusion of any specific engagement.

(22) The cost of surveys, when required, are not included in any of the fees mentioned in this schedule and are to be paid for by the client unless otherwise specifically agreed to by the engineer.

(23) Where the terms "Member of this Association," "Structural Engineer" or "Engineer" are mentioned in the Code of Practice and in this Schedule of Fees, they shall be interpreted to mean a Registered Structural Engineer of the State of Illinois, in good standing as a member of the Structural Engineers' Association of Illinois.

Artificial Seasoning of Gage Steels

The investigation by the U. S. Bureau of Standards on the effects of various artificial seasoning treatments on the permanence of gage steels has progressed sufficiently far to permit the drawing of certain conclusions. In this work hardened gages were heated in oil at various temperatures and under varying time conditions, and also subjected to seasoning by alternate dipping in hot oil and iced brine. The results of the work are as follows:

Short gages (¼ in.) showed no appreciable changes in length, with or without various artificial seasoning treatments, over a period of approximately 7 months, beginning about 1 to 2 weeks after hardening. In general the long gages (2 in.) showed no appreciable changes in planeness.

For studying length changes with time, gage blocks of greater length than those used (2 in.) would be desirable. About 6 to 8 in. is recommended.

Duplicate gages show wide variations in length changes; for example, one block showed no dimensional change in 217 days between first and last measurements while a duplicate decreased eighteen hundred thousandths of an inch in length in the same period.

Except in the case of plain-carbon steel containing 1.18 per cent carbon the changes in planeness are not appreciable. In this steel relatively large variations in planeness for duplicate gages are noted.

Gages produced from stainless steel and ordinary drill rod are softer than reference blocks ordinarily produced and which are kept between about 90 to 100 Shore hardness. From this standpoint, the stainless steel is unsatisfactory as it is not possible with ordinary treatment to maintain the hardness within the limits described. A higher-carbon alloy of this type would be more desirable, with possibly a decrease in chromium such as would not impair its stainless qualities and at the same time reduce production costs.

The plain-carbon steel (containing 1.8 per cent carbon) appears to be the least desirable from the standpoint of permanence, showing in the main the greatest changes in length and planeness during a period approximately 7 months from first to last measurements. Probably the most desirable are steels HC and K subjected to definite seasoning treatments, the former being the steel now generally used in production of reference gages at the Bureau of Standards.

Measurements at intervals of approximately 1 week, 1, 2, 4 and 7 months after initial readings of length and planeness do not give very much information regarding the progress of the changes taking place. Where the greatest changes occur in either length or planeness they appear to progressively increase with time. In many cases where these changes have been smallest over the entire time interval they seem to occur in the intervals immediately following the first measurement, the gages thereafter remaining constant.

November Contracts for Fabricating Shops.—The records of the Bridge Builders' & Structural Society, from reports collected by its secretary, show that urding the month of November, 1920, 49,200 tons of fabricated structuarl steel were contracted for throughout the United States, equivalent to 27½ per cent of the entire capacity of the bridge and structural shops of the country.

Relation Between Static and Dynamic Stresses in Girder Spans for Smooth Rolling Loads

Numerous recent tests [illegible] that the dynamic effect of rolling loads on bridges [illegible] much over estimated. This is particularly true of [illegible] which the loads are smooth rolling wheels [illegible] has no reciprocating motion. In a paper [illegible] for the American Society of Civil Engineers, Mr. F. W. [illegible] the following conclusions on this subject, [illegible] investigation of the relation between the static and dynamic stresses in girder spans for smooth rolling loads:

1. For speeds that obtain in railroad practice the dynamic effect of smooth rolling loads is so small that it may be neglected.

2. There is a critical speed that produces a maximum dynamic increment of stress for a single load and this speed is equal to 1,184 $\frac{r}{L}$ ft. per second, or [illegible] $\frac{r}{L}$ miles per hour, where r is the radius of gyration and L the length in inches.

3. The dynamic increment of stress for a single load for the critical speed is 31.8 per cent.

4. That even for the maximum speed condition with the wheel spacing usual on electric trains, the combined dynamic effect of four wheels may be less than the static effect.

Mr. Gardiner's paper, which has been issued in pamphlet form by the American Society of Civil Engineers, follows:

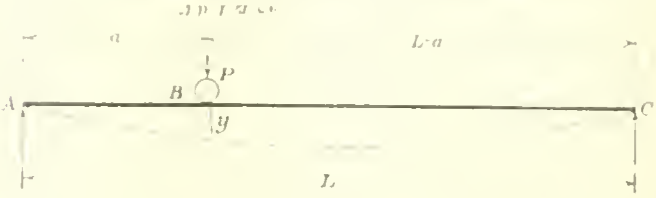


Fig. 1.

The following is an investigation of the stresses produced in a beam, supported at the ends, by a load rolling over it from one support to the other. The object of making the investigation is to determine the relation between the stresses produced by a smooth rolling load and those produced by a static load.

If the effect of the mass of the beam is omitted in the investigation, it will be found that the stress produced by a smooth rolling load is equal to the static stress plus a small increment due to the centrifugal force of the load moving in the arc formed by the elastic curve. The effect of centrifugal force is also omitted in this discussion.

This statement is not new and may be found in some recent textbooks on mechanics. A short proof of this statement is given because it is necessary that it be made clear before proceeding to investigate the effect of the mass of the beam.

Let A C, Fig. 1, be a beam supported at A and C, and P a load rolled on from A to C. The deflection, y, produced by a static load, P, at the distance, a, from the support is

$$y = \frac{P}{6\,E\,I\,L}\,[2\,a^2\,(L-a)^2]$$

The internal work done on the beam by a load, P, rolling from A to B, is

$$W_1 = \frac{P^2\,a^2}{6\,E\,I\,L}\,(L-a)^2$$

The average force acting through the deflection, y, is equal to the work divided by the distance

$$\frac{W_1}{y} = \frac{P^2\,a^2}{6\,E\,I\,L}\,(L-a)^2 \times \frac{6\,E\,I\,L}{P\,[2\,a^2\,(L-a)^2]} = \frac{P}{2} \qquad (1)$$

The whole load, P, has passed through a vertical distance, y, when the load has reached a position, B, distant a from the support, A, and, therefore, the total external work is Py. It has been shown that one-half of this work, $\frac{Py}{2}$, is absorbed by internal work in the beam. The unbalanced average load $\frac{P}{2}$, acting on the mass of the load, P, and accelerating it [illegible] the [illegible] formed by the elastic curve [illegible] stored energy in the acceleration of the mass [illegible] $\frac{P}{2}y$.

When the load has reached Position B the whole work of the load P is absorbed therefore, by the elastic deflection and the acceleration of the mass of the load. It will be noted that the component of P producing acceleration of the mass is tangential to the elastic curve and the change of direction of this acceleration produces a centrifugal force radial to the curve.

It is true, therefore, as stated, that the stress produced by a smooth rolling load at any velocity is the static stress plus a small increment due to centrifugal force, when the effect of the mass of the beam is not considered.

It is now proposed to consider the effect of the mass of the beam.

Let A C, Fig. 2, represent a beam supported at A and C, and P a load rolling from A to C with a constant velocity, V.

It is proposed to write the equation of the distance-time curve of the deflection of the center of the beam.

Let m be an equivalent mass concentrated at the center of gravity of the mass of the beam, and assume this equivalent mass to be constant during the deflection. The relation of this mass to the total mass of the beam will be shown later.

Let A = the vertical acceleration of the mass, m;
y = the vertical deflection of the center of the beam;
t = the time the load, P, takes to go a distance a.

The deflection of the center of the beam for any position of the load, P, will be the static deflection minus the deflection due to the force, m A, applied at the center of the beam.

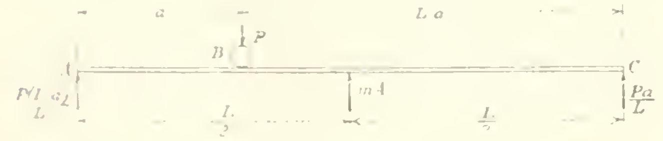


Fig. 2.

The equation of the distance-time curve of the deflection of the center of the beam, is, therefore, for all values of a from 0 to $\frac{L}{2}$:

$$y = \frac{Pa}{48EI}(3L^2 - 4a^2) - \frac{mL^3}{48EI}\frac{d^2y}{dt^2} \quad \ldots\ldots\ldots\ldots (2)$$

Let $\frac{P}{48EI} = C_1$; $\frac{mL^3}{48EI} = C_2$; $a = Ct$, where C = velocity.

$$\text{Then } y = C_1Ct(3L^2 - 4C^2t^2) - C_2\frac{d^2y}{dt^2} \quad \ldots\ldots\ldots\ldots (3)$$

$$y + C_2\frac{d^2y}{dt^2} = C_1Ct(3L^2 - 4C^2t^2) \quad \ldots\ldots\ldots\ldots (4)$$

The solution of this differential equation gives

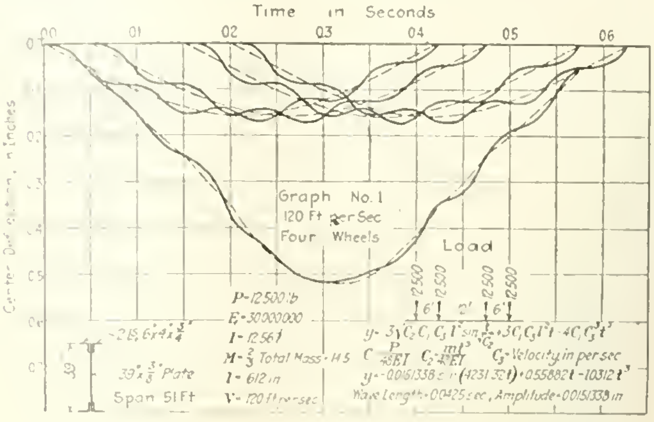
$$y = -3\sqrt{C_2}\,C_1CL^2\sin\frac{t}{\sqrt{C_2}} + 3C_1CL^2t - 4C_1C^3t^3 \quad \ldots (5)$$

and this is the equation of the distance-time curve of the deflection of the center of the span for values of t from zero to a value making the distance traveled by the load one-half the span length. It will be noted that in this equation the first term is the effect of the mass of the beam, and the last two terms the elastic deflection in a beam of no mass. The equation for the remaining half of the beam has the same first term and a remaining term giving symmetrical values about the center line with those given in Equation (5). This equation is, therefore, all that is necessary to plot the distance-time curve.

The value to be given to the equivalent mass, m, acting at the center of gravity of the beam was found by plotting the elastic curve for 10 positions of the load between the support and the center of the beam and computing the vertical displacement of the center of gravity of the mass. It was found that for a deflection, y, at the center, the center of gravity of the beam was deflected a little less than $\frac{2}{3}y$, and that this relation was nearly constant throughout the whole deflection. A value of two-thirds of the total mass of the beam has been used, therefore, for the quantity, m, in the equation.

Graph No. 1, Fig. 3, is a graph of this equation for a rather flexible girder 39 in. deep and of 51-ft. span, with four wheels of 12,500 lb. each passing over it at a speed of 120 ft. per second, or 82 miles per hour, representing a high railroad speed.

The dotted lines represent the distance-time curves of a beam of no mass. The increment of deflection in this case due to the mass of the beam is about 10 per cent for a single load and less than 3 per cent for the combined action of four wheels.



$y = -3\sqrt{C_2}C_1C_3l^2\sin\frac{t}{\sqrt{C_2}} + 3C_1C_3l^2t - 4C_1C_3^3t^3$
$C_1 = \frac{P}{48EI}$ $C_2 = \frac{ml^3}{48EI}$
$y = -0.0151338\sin(423.1321t) + 0.558821t - 1.0312t^3$

Fig. 3.

A graph of the same girder with the same load passing over it at a speed of 30 ft. per second, or 20.4 miles per hour, would show that the wave motion caused by the mass inertia has the same time length and one-quarter the amplitude of the first graph, and as the velocity is decreased the wave amplitude will decrease and the graph approach closer and closer to the curve of no mass.

Graph No. 2, Fig. 4, is a graph of the same girder with the same load passing over it at a speed of 400 ft. per second, or 273 miles per hour. The wave in this case has the same time length and 3⅓ times the amplitude of Graph No. 1. The increment of deflection due to a single load is in this case 31.8 per cent and this is the maximum increment that can be produced by a single load, as will be shown later. For speeds greater than 400 ft. per second, the value of the deflection decreases. Graph No. 3, Fig. 4, is a graph for the same girder with the same load passing over it at a speed of 1,200 ft. per second, or 830 miles per hour. The deflection in this case is about 6 per cent of the no-mass deflection and as the speed increases the deflection will decrease, approaching the value zero when the speed becomes infinite.

A study of these graphs makes it evident that there is a speed which produced a maximum mass effect for a single load, and an examination of the equation enables this value to be found.

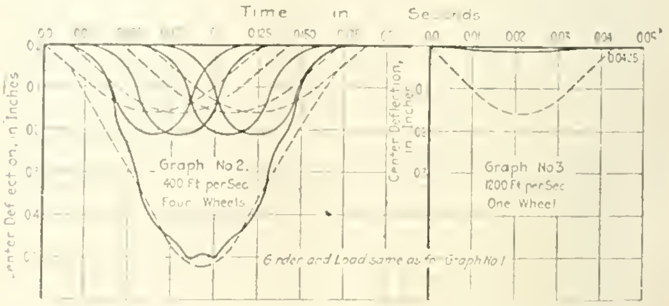


Fig. 4.

Consider the first term of the equation which, as previously stated, gives the mass effect, that is,

$$3\sqrt{C_2}\,C_1CL^2\sin\frac{t}{\sqrt{C_2}}$$

The inertia of the mass produces a maximum effect when the velocity has a value such that the wheel load arrives at the center of the span in a time, t, having a value such that the angle, $\frac{t}{\sqrt{C_2}} \times \frac{180}{\pi}$ is 270°, and, therefore, the sin is —1.

Let this value of the velocity be V. Then.

$$\frac{t}{\sqrt{C_1}} \cdot \frac{180}{\pi} = 270, \text{ or } t = \frac{3\pi\sqrt{C_1}}{2}$$

$$V = \frac{L}{2t} = \frac{L}{2} \cdot \frac{2}{3\pi\sqrt{C_1}} = \frac{L}{3\pi\sqrt{C_1}} = \frac{L}{3\pi}\sqrt{\frac{48EI}{mL^3}}$$

$$V^2 = \frac{L^2}{9\pi^2} \cdot \frac{48EI}{mL^3} = \frac{16EI}{3\pi^2 mL}$$

Since $m = \frac{ALw}{2g}$

$$V^2 = \frac{16EI}{3\pi^2 L} \times \frac{3g}{2ALw} = \frac{16EAr^2g}{\pi^2L \, 2ALw} = \frac{16Er^2g}{2\pi^2L^2w}$$

$$V = \frac{4r}{\pi L}\sqrt{\frac{Eg}{2w}} = \frac{4}{\pi}\sqrt{\frac{Eg}{2w}} \cdot \frac{r}{L} \text{ (a constant)}$$

For a steel girder the value of this constant is

$$\frac{4}{3.1416}\sqrt{\frac{30{,}000{,}000 \times 32.2 \times 12}{2 \times 0.28}} = 182{,}213$$

and the value of the velocity giving the maximum mass effect is

$$V_{max} = 182{,}213\frac{r}{L} \text{ in. per sec. or } 15{,}184\frac{r}{L} \text{ ft. per sec.}$$

in which r is the radius of gyration and L the length, in inches.

The deflection for velocity, V, or when

$$V = \frac{L}{3\pi\sqrt{C_1}} = C_2, \text{ and } \sin\frac{t}{\sqrt{C_1}} = -1$$

is the no-mass deflection plus the quantity

$$3\pi C_2 C_1 C_3 L = 3\pi C_2 C_3 \frac{L}{3\pi\sqrt{C_1}} = \frac{C_3 L}{\pi} = \frac{PL^3}{48EI\pi}$$

The no-mass deflection with the load at the center of the span is $\frac{PL^3}{48EI}$. Then

$$\frac{\text{Mass increment}}{\text{No-mass deflection}} = \frac{PL^3}{48EI\pi} \cdot \frac{48EI}{PL^3} = \frac{1}{\pi}$$

The mass increment of deflection, therefore, has a maximum value for a single wheel load 31.83 per cent of the no-mass or static deflection and this occurs only for the critical velocity,

$$V_{max} = 15{,}184\frac{r}{L} \text{ ft. per second.}$$

The girder for which the graphs are shown has a value of $\frac{r}{L} = 0.0263$ and a value of $V_{max} = 400$ ft. per second; or 271 miles per hour. The graph, Fig. 4, is, therefore, the maximum condition for a single load.

An average value for new elevated railway structures is $\frac{r}{L} = 0.0397$, for which $V_{max} = 600$ ft. per second, or 410 miles per hour.

The stress in any girder is a constant times the deflection, and the relation between the deflection at the center, and the no-mass or static deflection given by Equation (5) is the relation sought to be established by this investigation.

Test to Determine the Deflection of Girders Due to a Moving Load. A test was made on Feb. 17, 1918, on track stringers on the express track of the Third Ave. Line of the Manhattan Railway Division of the Interborough Rapid Transit Co., New York City. Two composite cars were loaded with brake shoes to equal the live load for a fully loaded train. The test was made in Span 806 at 91st St. The track stringers in this span are plate girders, 45 ft. long and 39 in. deep, with ½-in. web spliced at the midpoint, and each flange consisting of two 6 by 6 by ⅝-in. angles.

Two independent methods were used simultaneously to ascertain the deflections, as follows:

One method consisted of fastening a piano wire to the end stiffeners of the track [illegible] partly along the neutral axis of the stringer [illegible] about 4 in. from its face. At the middle of the [illegible] was wedged tightly between the top and bottom [illegible]. On the side of the board facing the wire, and [illegible] it a card was fastened with thumb tacks to hold it in place. A pencil firmly fastened to the wire with its point in contact with the paper registered any vertical movement of the girder. After each test the card was removed, properly labeled for identification, and a new card put in place. Later, the length of the line scribed on the card was scaled. The length so measured represented the true deflection of the girder due to a particular load at a definite speed.

The second method was by direct rod readings, using sliding level rods provided with strap iron hooks so fastened to the upper sections of the rod that it could be suspended from the flange of the girder by allowing the point of the hook to rest on the top surface of the horizontal leg of the lower flange angle. With the rod free to slide and the bottom of the lower section resting on the street surface below, the movement between the free sections of the rod will indicate the vertical deflection caused by any live load passing over the girder. At a convenient place opposite the sliding sections of the level rod, a horizontal strip of metal was fastened on the side of the lower section or fixed part of the level rod and extended beyond the side of the upper section or movable part. Back of the strip of metal a card was fastened on the upper or movable section. With the rod hanging from the girder, with the parts free to slide and the bottom in contact with the street below, the rods in position to register deflections. For each reading three rods were used, one at each end and one at the middle. When the rods were so placed, a pencil line was drawn across the top edge of the metal strip on the card and the point of the pencil was kept in contact with the card. As the load passed over the girder, the mark made by the pencil recorded the true deflection of the girder due to the live load at the center and ends. The rod readings were taken at the ends and the center simultaneously to eliminate deflections of other parts of the structure and the recorded deflection at the center was corrected accordingly. As with the first method, the deflections were obtained by scaling the length of line scribed on the card. The two methods gave results which in no case differed more than 1/32 in.

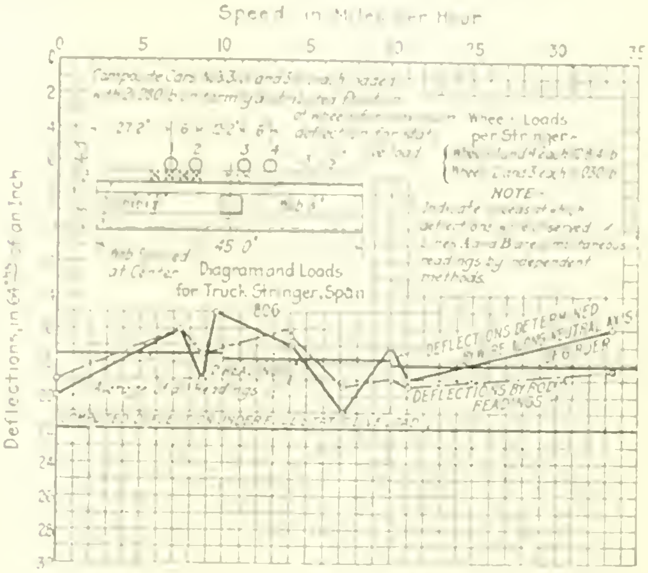


Fig. 5.

The test was begun by first placing the cars on the girders in the position to give maximum deflection for static live load.

The train was then run over the track girder at various speeds and the deflection noted. The speed was measured by placing markers along the track 176 ft. apart or 88 ft. each way from the center of the girder. The train was then run at various speeds. By means of a registering device on the train, the time required to pass over a distance of 176 ft. was recorded, and read to tenths of a second, and from this information the speed in miles per hour was computed. Ten trips were made, with speeds varying from 7½ to 33⅓ miles per hour. The results of these tests are shown [illegible]. Some of these results indicate that:

1. The computed deflection for static load is greater than the measured deflection caused by the static load.

2. The observed deflections for moving load were less than the observed deflection for static load, except at a speed of 17 miles per hour, in which case the deflection was slightly greater.

Pressure of Concrete Against Forms During Pouring

Technologic Paper No. 175 issued Oct. 11 by the U. S. Bureau of Standards gives the results of measurements of the pressure of concrete against forms made during the pouring of a large reinforced concrete test specimen. This specimen was poured for the concrete ship section of the Emergency Fleet Corporation at the Bureau of Standards in Washington, D. C., on May 10, 1918. The specimen had a height of 16 ft. 11 in., and at points where the horizontal pressure was measured it had a thickness of 2 in. The concrete used consisted of 1 part of a standard portland cement, two-thirds part of Potomac River sand and 1⅓ parts of gravel under ½ in. in size. Proportions were measured by volume. The amount of water used was about 12.5 per cent of the combined weight of the dry materials. The consistency of the concrete was measured by lifting a 6 by 12-in. cylindrical mold from a freshly poured control specimen. The measured diameter of the puddle thus formed was taken as a measure of the consistency of the concrete entering into the specimen. The pressure measurements were made by means of pressure cells which have been developed by the Bureau of Public Roads in investigational work on earth pressures. The results of the tests are summarized as follows in the paper:

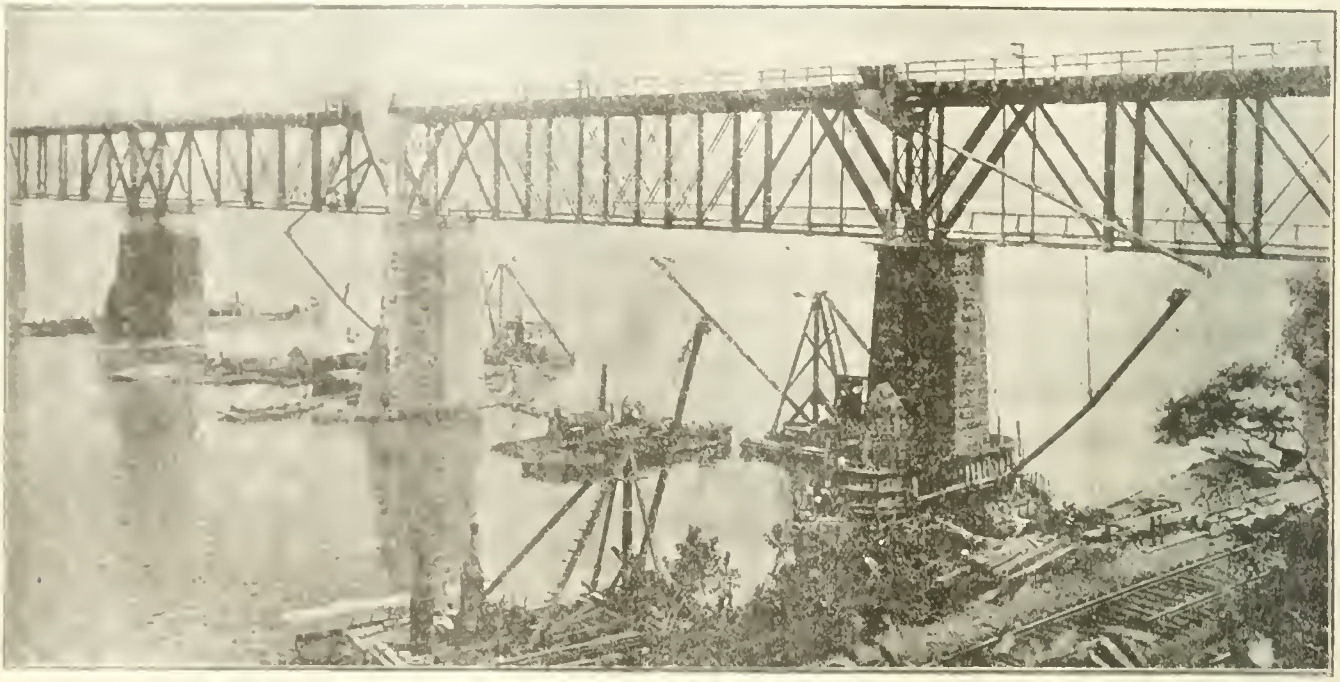
The maximum pressure against the forms during pouring of concrete was found to be equivalent to that of a liquid weighing about 124 lb. per cubic foot.

The maximum pressure was found to be that due to the head of concrete existing at the end of about 40 minutes. After that time the pressure gradually decreased in spite of increasing head of concrete.

Design Special Boxes for Transporting T. N. T.—The Forest Products Laboratory of Forest Service, United States Department of Agriculture, at Madison, Wis., is at present engaged in designing a box which will be the safest possible one to use in transporting T. N. T. This is at the request of the [illegible] Division of the Army which has 15,000,000 lb. of [illegible] explosives to move.

Construction Features of a 46-Arch Railroad Bridge

The Philadelphia & Reading Ry. is now replacing its single track crossing of the Susquehanna River at Harrisburg, Pa., by a double-track reinforced concrete bridge, consisting of 46 arches measuring approximately 76 ft. from center to center of piers. The new bridge will replace a wrought-iron deck truss structure having 23 spans, 149 ft. 4 in. center to center of end pins and 24 ft. 9 in. from center to center of upper and lower chords, and one 69-ft. through plate girder bridge spanning the tracks of the Northern Central. The river piers were built originally for double track, and the superstructure for single track, though it was so designed that a third truss could be added whenever two tracks were required. The masonry for this old bridge, which was completed in 1890, including the approach work through the city, contained approximately 6,258 cu. yd. of masonry on land, and 9,773 cu. yd. in the river piers, the latter being built in range-work from bed-rock to copings and composed of Clearfield County sandstone, laid with cement.


The Old Bridge, Showing Work of Encasing the Old Piers and the Building of the New Intermediate Piers.

An interesting description of the new bridge is given by Mr. E. Chamberlain, Assistant Engineer P. & R. Ry., in the Railway Age, to which we are indebted for the matter and illustrations in this article.

Originally the completed single track occupied its double-track position, or about 1 ft. 7½ in. off center of the bridge trusses, each of which was designed to carry two-thirds of a single track load. With the increasing engine and train loads, it was found that the masonry in the tops of many of the piers was being displaced, necessitating the reconstruction of the tops of these piers. It was also ascertained that a number of the eye-bars of the trusses were loose, increasing the load carried by the other bars to an unknown extent. The trusses were apparently deficient in rigidity and swung considerably during the passage of trains. To relieve this condition, the track was shifted so as to bring two-thirds of the single track load on the heavier truss, and the speed of trains was reduced to 10 miles per hour as a temporary expedient. The traffic is exceedingly heavy at this point, consisting almost entirely of solid through trains of the Philadelphia & Reading, the Baltimore & Ohio, the Norfolk & Western, the Western Maryland and the Cumberland Valley. The number of trains using this bridge in completed movements daily is 75, without counting switching movements, and the daily revenue tonnage averages about 140,000.

The new structure, which will be built on the same alinement and on practically the same grade as the present bridge, will have 46 arches having an average clear span of 66 ft. It will be built entirely of concrete and for two tracks with a total length of 3,507 ft. 9 in. center to center of end piers, The base of rail at the eastern pier is about 54 ft. above normal water in the river, and at the western pier about 79 ft., the grade on the bridge being 0.7 per cent. The depth of water in the river, and at the western pier about 79 ft., the grade on the bridge being 0.7 per cent. The depth of water in the river ranges from about 2 ft. as a minimum to 8 ft. 6 in. as a maximum.

The old piers, which are supported on a rock bottom, are to be encased in concrete and new intermediate piers built. The concrete encasement around the old piers will have a minimum thickness of 18 in., reinforced with [illegible]-in. rods spaced 2 ft. center to center both ways and with expansion bolts 6 ft. apart anchored 12 in. into the old piers. Each of the reconstructed piers will have a thickness at the springing line of 11 ft. 6 in., while the new intermediate piers will have a thickness of 9 ft. All foundations will be approximately 51 ft. 9 in. long at the base and 35 ft. long above the nosing and up to the parapet.

The arch ring is of semi-circular design with radii of [illegible] ft. and 64 ft., giving a crown thickness of 3 ft., and a radial width at the haunch where it joins the pier section, of about 11 ft. The ring is thoroughly reinforced for temperature changes and will be poured in sections in the usual manner for this type of construction. A clearance of 28½ ft. has been provided for figuring on a basis of the maximum high water in the past.

The spandrel walls are reinforced and have a batter on the back face of 5 in. in 12 in. They are surmounted by a concrete coping of simple design in which a 4-way vitrified clay duct is placed on each side of the bridge to carry the necessary present and future wiring, terminating in hand holes spaced 250 ft. apart on both sides. The reinforced concrete railing, 4 ft. in height, will consist of ornamental posts and intermediate solid panels, built up on the copings, and having a clear width between inside faces of 30 ft. 8 in. The over all width of the [illegible] faces of rings is 32 ft. and the clear width between [illegible] 29 ft.

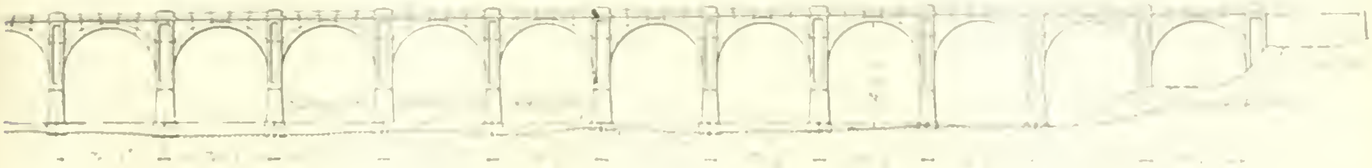
The faces of the arch rings and spandrels will be plain except for V grooves at [illegible] joints. The tops of the arches and the inside faces of the spandrel walls are to be waterproofed with two layers of cotton fabric saturated and cemented together with asphalt. This membrane will have a 2½-in. concrete protection course of 1:2:4 mix with ⅜-in. stone and reinforced by No. 1[illegible] welded wire cloth with a 4 in. by 4 in. mesh.

Drainage at each pier will be secured by means of cast iron pipes 8-in. in diameter carried through the arch ring. The space between the spandrel walls and over the arch rings will be built up and filled with dry stone packing, of what is commonly known as one and two man size, to about 1 ft. 9 in. below the top of the rail.

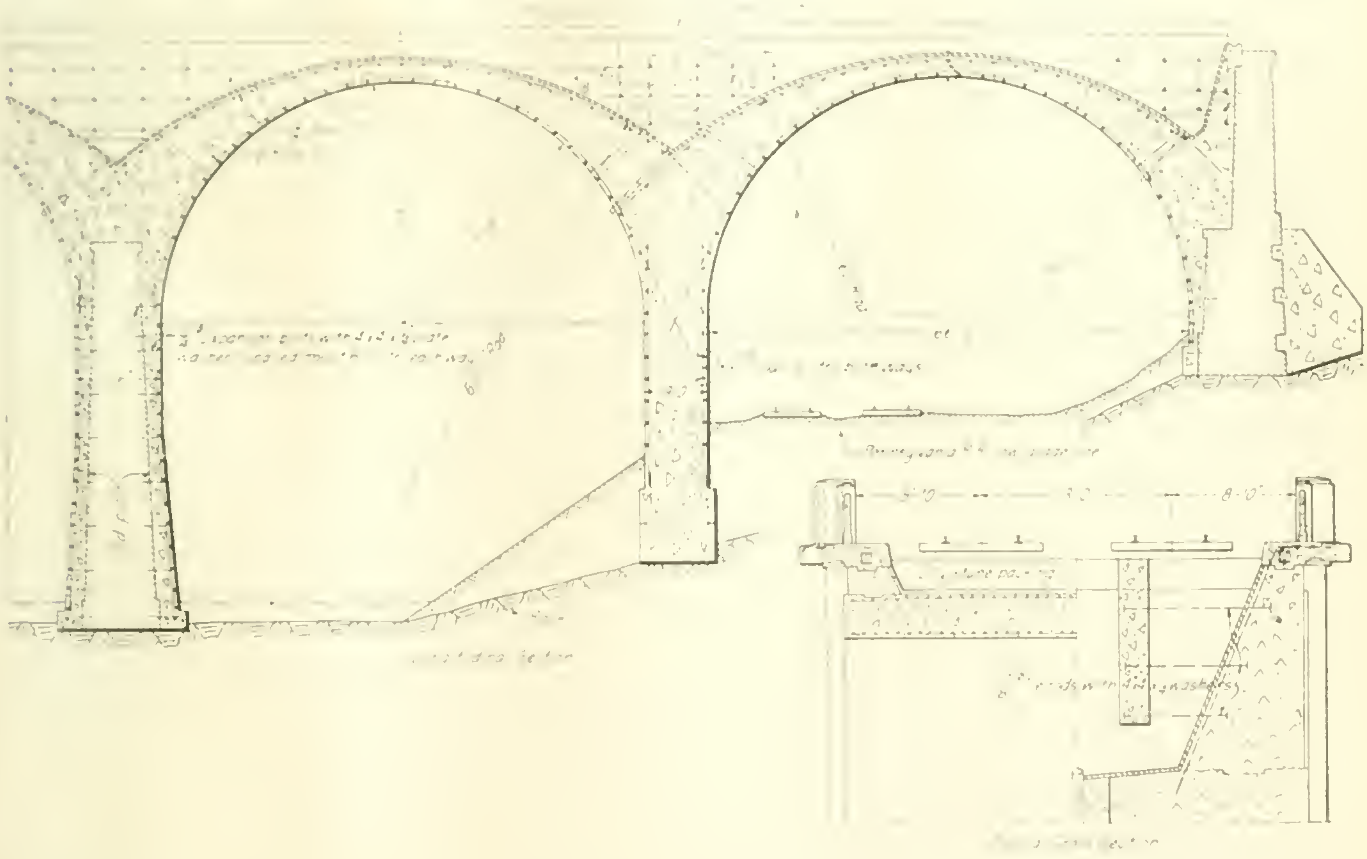
The coffer-dams now being used for the river piers are generally of the Blaw Knox type of steel framework, with two lines of Lackawanna steel sheet piling, about 18 in. apart, enclosing the puddle wall. Four and 8-in. pumps are being used for unwatering these dams.

Work is proceeding from both shores, separate concrete mixing plants having been installed at each end of the bridge. On the east bank of the river the mixing plant has been located at ground level and the concrete is being elevated to the top of the bridge, where it is discharged into side dump cars. These are conveyed to the work on a 24-in. gage railway by 3-ton gasoline locomotives, and the concrete is distributed to the different foundations through separate steel chutes. At the western end, the concrete is dumped from the mixer to the cars direct and then conveyed to the work in a similar manner.

In order to continue traffic over the present bridge during construction it was necessary that the arch rings be built in two longitudinal sections. On the completion of the founda-



Part Elevation of New Bridge of Philadelphia & Reading R. Over Susquehanna River at Harrisburg, Pa.



Typical Details of New Bridge.

tions the first section, 13 ft 6 in wide [illegible] on the downstream side of the present bridge [illegible] to retain the stone fill supporting the track a [illegible] built up of reinforced concrete 2 ft wide [illegible] to the spandrel walls by ⅞-in tie rods. When [illegible] traffic will be transferred to this section, after which the old superstructure will be dismantled and the [illegible] section of arch rings completed.

Steel centering will be used for the arch rings. These will be supported upon steel brackets inserted in pockets formed in the face of the piers below the springing line. All concrete will be of a 1:2:4 mixture, using a [illegible] crushed stone throughout except in the railing which will be of [illegible]-in. size. The approximate quantity of concrete in the new structure is [illegible] cu. yd.

The new structure, as well as the other secondary structures, which are to be renewed was designed by and is now being constructed under the direction of the engineering department of the Philadelphia & Reading Ry., Samuel T. Wagner, Chief Engineer, Clark Dillenbeck, Assistant Chief Engineers, and P. S. Baker, Engineer of Bridges and Buildings. The field work is in charge of C. H. Hitchcock and E. Chamberlain, Assistant Engineers. The contractors on the work are the James McGraw Co., Philadelphia, Pa., and T. L. Eyre, Philadelphia, to whom the foundation work was sub-let.

Co-Operation in the Building Industry*

By L. K. COMSTOCK

The one great interest we are all striving for is the regeneration of the industry and the enthronement of reason where prejudice now exists, and the substitution of harmony for discord. In bringing about this grand result, five groups are necessary—the Architect, Engineer, Contractor, Sub-contractor and Labor. Each group has its own appointed task, and together they should move forward with the harmony and the rhythm of a great army under the leadership of a general staff, which, composed of experts representing all the divisions, has worked out the grand strategy according to its understanding of the problems involved and the objective.

This is our common interest and you will at once perceive that the interest is complex and perhaps confused and full of cross currents of individual interest, apparently and probably at variance with the direction of the grand common purpose. In proportion as these cross currents of individual interest are allowed full play, the grand strategy of the industry is in danger of failing to reach its objective. Our common interest demands organization, organization demands direction, and direction demands conference, conference demands compromise, compromise demands self-subordination and self-subordination demands courage of the highest order.

We are too apt, in spite of our willingness to regenerate the industry to regard its present characteristics, and group isolation, as fixed and unalterable. Nothing is permanent and beyond alteration, and if proof of this is necessary, consider the Eighteenth and Nineteenth amendments to the Constitution of the United States.

Your architects form the professional wing of this great industrial army. Despite your professionalism and what some of you have regarded as a splendid isolation from commercialism because you sell nothing but service, nevertheless you are salesmen. The lawyer is a salesman, the minister is a salesman, everyone is a salesman whose name is not yet on a tombstone and who still has an idea worth passing along. Notwithstanding your professional training and your broader culture you need in common with all other groups in the industry a more vivid realization of the socializing forces at work and a more lively perception of the necessity of a code which will link you up harmoniously with the other groups.

The orderly arrangement of our industry is not going to be based on logic but rather on experience, and experience teaches that the welfare of others is linked up with our own, no matter what we do. Organization of the industry into an industry organization is not impossible nor is it easy, nor will it be made easier by constantly thinking how hard it is. There will be little hope for the rescue of the industry, except [illegible] industry organization.

The Economic Proportioning of Structural Members

The interpretation of Building Codes as to the amount of reduction permitted in the loads carried by the girders and columns of a building is very often very difficult and even when properly interpreted the results are very often illogical. In the Dec. 2 issue of the Canadian Engineer Prof. C. R. Young of the University of Toronto has analyzed the subject very thoroughly, including a review of the various building ordinances in this problem, and has submitted a recommendation that should help a structural designer very materially. As an example he shows that where a load of 1,465 lb. per square foot of floor is possible on a lower floor column of a 20-story building, Philadelphia permits a load of 424 lb. to be used in the design of columns, while New York, Minneapolis and Toronto require 959 lb. per square foot. His article follows, practically verbatim.

Economic proportioning of members in buildings, bridges and other structures requires careful consideration of the probability of occurrence of possible maximum loads. In most cases it would be prohibitive to design a structure on the basis of the usual permissible stresses to provide for the greatest load that might conceivably be massed upon the structure. Instead, it is universal practice to discount somewhat the likelihood of extreme loads being brought to bear, and to provide for them at stresses but little below the elastic limit of the material used. In bridge work, for example, it is customary to assume a uniform live load much less for long spans than for short ones. The Dominion Government specification for highway bridges provides that for Class 1 bridges the uniform live load shall be taken as 100 lb. per square foot for spans up to 100 ft. in length, 60 lb. per square foot for spans of 250 ft. in length, and proportionate amounts for intermediate spans. Similar reductions of live load are provided for in the Ontario Government specifications. In designing the Manhattan suspension bridge at New York City, provision was made for a normal maximum moving load of 8,000 lb. per lineal foot, to cover heavy regulated traffic, although it was recognized that it might be possible to produce a load of 16,000 lb. per lineal foot by an extreme congestion of traffic. The structure was so proportioned that if this should ever come about, it still would be able to carry the load, although at a considerably reduced factor of safety.

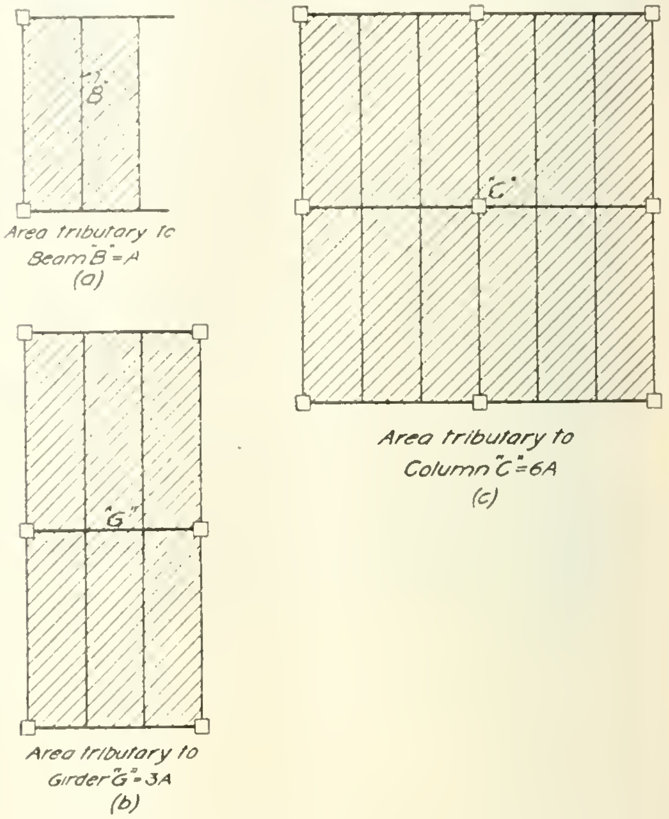

"B"
Area tributary to Beam "B" = A
(a)
"G"
Area tributary to Girder "G" = 3A
(b)
"C"
Area tributary to Column "C" = 6A
(c)

Fig. 1—Relative Areas Tributary to a Beam, Girder and Column on One Floor.

---

*[illegible] 12 before the meeting of the [illegible]

Not only is it customary to reduce specified loads to provide for the unlikelihood of extreme occurrences, but increases in permissible stresses are permitted to provide for unusual or unlikely combinations of vertical loading, wind and temperature. For example, in the new specifications for steel railway bridges of the Canadian Engineering Standards Association, it is specified that for the sum of the axial and bending stresses (including secondary stress) due to dead load, live load, impact, centrifugal force, wind load, longitudinal force and temperature effect, the permissible stress may be increased 50 per cent.

Variable Loads in Buildings. In building work, the improbability of specified maximum live loads arising over very large areas is generally recognized. While in warehouses and buildings used for the storage and manufacture of goods, the occurrence of large loads on all floors at once is probable, in buildings where the human load is an important factor, such as office buildings, hotels, apartment houses, and the like, large reductions from the maximum specified loads are warranted in the case of large tributary areas. In an office building, for example, where very many different kinds of businesses are represented, and where a great diversity of interests on the part of those who use and visit the building exists, it is not likely that a congested loading will occur over any considerable area.

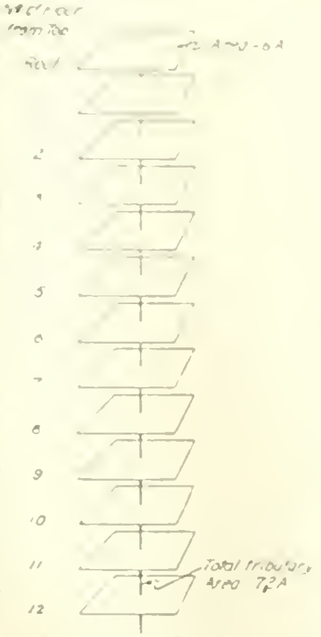


Fig. 2—Areas Tributary to Various Column Tiers.

Experiment has shown that it is possible, by selection, to obtain a human load on small areas amounting to over 180 lb. per square foot, as was found in the classic experiments of Prof. L. J. Johnson. Loads produced by a chance grouping of people, however, are never likely to exceed 120 lb. per square foot, and even then such loads would be obtained only over very restricted areas. When the area involved rises to 150 square feet or more, the average weight of a comfortable crowd would perhaps not exceed 40 to 50 lb. per square foot.

Many observers testify to tse surprising smallness of the moving live load on the floors of office buildings. Investigations of Blackall and Everett, made on three large office buildings in Boston, showed that the greatest live load in any one office amounted to 40.2 lb. per square foot. The greatest maximum average for all floors of any one of the buildings investigated was 17 lb. per square foot, or 42 per cent of the maximum observed floor load on any one floor. These investigations, which have been substantiated by many subsequent observers, give basis for the belief that a considerable reduction in specified live load should be made both for girders and columns.

Reduction for Girders.—Warrant for the reduction of live load on girders arises from the fact that in order that a girder may receive the maximum possible live load, a much larger area must be covered with load than must be covered to produce the maximum possible load in a beam. In addition, the load on the girder requires a much longer time to attain its maximum than does the load on the beam and hence the impact factor is much less severe for the girder. Graphical demonstration of the soundness of this contention may be obtained from Fig. 1. Assuming a common subdivision of the panel, that is, into three spaces, and letting the area that must be entirely covered with load in order that the beam "B" (sketch a) may receive its maximum load be represented by "A," the area that would need to be fully loaded in order that the girder "G" (sketch b) may receive its full load would be 3A. It is evident, of course, that there is much less likelihood of the girder "G" receiving its full maximum possible live load than there is for the beam "B," since three times as much area must be covered in the case of the girder as in the case of the beam. In an average case, the total area that would need to be covered to produce a maximum load in the girder "G" would be 600 or 700 sq. ft. Very unusual conditions would need to occur in the case of a human load for this to be brought about, as upon a space of 600 sq. ft., 200 people of an average weight of 150 lb. each would have to be placed in order to realize a live load of only 50 lb. per square foot. While specifications and building codes differ in the reduction allowance permitted, there is very general disposition to recognize the improbability of full maximum live load occurring on girders.

Table I indicates the practice in this regard for a number of representative codes and specifications, some of which allow a reduction and some of which do not. It is seen from these that the average reduction allowed is about 15 per cent. Manifestly, some consideration should be given to the size of the area carried by the girder, as, for example, is done in the case of the Boston code, where the reduction is 10 per cent for girders carrying over 100 sq. ft. of area, 15 per cent for girders carrying 200 sq. ft., and 25 per cent for girders carrying over 300 sq. ft. These reductions are very properly not allowed on girders for buildings such as warehouses, storehouses and heavy manufacturing buildings where goods may be piled up in large masses with only narrow aisles left between. To express average practice with respect to girder reductions, the writer would recommend the following specification:

For all buildings except warehouses, storehouses and buildings for the manufacture and sale of heavy goods, the specified floor live load may be reduced by 10 per cent for girders carrying 150 sq. ft. of floor, and 15 per cent for girders carrying 200 sq. ft. or more, of floor. For intermediate areas, the reductions may be proportionate percentages.

Reduction for Columns. If there is reason for reducing the specified floor live load in the case of girders, there is still greater reason for doing so in the case of columns. Whereas for the girder "G," shown in Fig. 1, the area that must be covered with live load to produce the full load on the girder is 3A, the area that must be covered with load in order that the column "C" may receive its full live load from one floor is as shown in Fig. 1 (c), namely, 6A, or twice as much as must be covered in the case of the girder. If we now consider the column tier between, say, the 11th and 12th floors from the top of the building, the total area that must be covered with the full specified live load, that is the total area

TABLE I—REDUCTION TO BE APPLIED TO SPECIFIED FLOOR LIVE LOADS IN CALCULATING LOADS ON GIRDERS.

Building Code or Specification.	Conditions Under Which Rule Is to Be Applied	Rule.
New York, 1917	None	No reduction specified.
Chicago, 1911	No restriction	Reduction not over 15%
Boston, 1919	For all buildings except armories, garages, gymnasiums, storage buildings, wholesale stores and assembly halls	Reduction for girders carrying over 100 sq. ft. of area, 10%. Reduction for girders carrying over 200 sq. ft. of area, 15%. Reduction for girders carrying over 300 sq. ft. of area, 25%.
Philadelphia, 1918	For tenement houses, hotels, apartment houses, hospitals and office buildings For light manufacturing buildings	Percentage of reduction = 0.80 (A)[illegible], where A = area carried. Percentage of reduction = 0.40 (A)[illegible], where A = area carried.
Minneapolis, 1920; National Board of Fire Underwriters, 1915; Toronto, 1913	None	No reduction specified.
Toronto, 1920 (proposed)	For all buildings except warehouses	Reduction, 15%.
R. Fleming, 1918	For all buildings except warehouses and heavy mercantile and manufacturing buildings	Reduction, 10% for girders carrying more than 150 sq. ft. of floor.
C. R. Young, 1920	For all buildings except warehouses, storehouses and buildings for manufacture and sale of heavy goods.	Reduction, 10% for girders carrying 150 sq. ft. of floor, and 15% for girders carrying 200 sq. ft. or more; proportionate amounts for intermediate areas.

[illegible] REDUCTION TO BE APPLIED TO SPECIFIED FLOOR LIVE LOADS IN CALCULATING LOADS ON COLUMNS.

[illegible] Specification	[illegible]	Rule.
N[illegible]	[illegible]	[illegible] below top floor, 85% of allowable live load, on next [illegible] each succeeding lower floor, correspondingly decreasing [illegible] not less than 50%.
[illegible]	[illegible]	[illegible] live load on top floor, 85% of specified floor load on next [illegible] succeeding floors, correspondingly decreasing percentages [illegible]
[illegible]	[illegible]	Columns carrying 1 floor .... No reduction. Columns carrying 2 floors .... 25% reduction. Columns carrying 3 floors .... 40% reduction. Columns carrying 4 floors .... 50% reduction. Columns carrying 5 floors .... 55% reduction Columns carrying 6 or more floors .... 60% reduction. [illegible] columns .... 25% reduction.
[illegible]	[illegible]	Percentage of total live load above $= 100 - 0.80(A)^{1/2}$, where A = area carried
	[illegible]	Percentage of total live load above $= 100 - 0.40(A)^{1/2}$.
M[illegible]	[illegible]	For roof and top floor full live loads; for each succeeding lower floor reduce live load by 5% until 50% is reached.
N[illegible] F[illegible]	[illegible]	For columns supporting roof and top floor, no reduction; for columns supporting each succeeding floor a reduction of 5% of the total live load per floor, the total deduction not to exceed 50%.
A[illegible]	For all buildings except warehouses.	Full live load for columns in top story; for second story from top, 85% of total live load above; for third story from top, 80% of total live load above; for succeeding lower stories, correspondingly decreasing percentages, till a minimum of 50% is reached.
	[illegible] warehouses.	As above, except that increment of reduction per story is 2½%.
[illegible]	For dwellings, office buildings, stores, stables and public buildings when over 5 stories high	For roof and top floor, full live load; for each succeeding lower floor live load reduced by 5% until 50% is reached, when such percentages shall be used for all remaining floors.
[illegible]	For columns over [illegible] tiers in height except in warehouses.	Specified live load on floors commencing with floor immediately above third tier from the top reduced 5% per floor for each successive lower floor, until a minimum of 50% thereof is reached.
C. C. Schneider, 1910	For columns carrying over 5 floors except in warehouses and similar buildings.	As interpreted by Schneider: No reduction of loads for columns supporting roof and top floor; total live loads on succeeding lower floors reduced by percentages beginning with 10% for the second floor from top, and increasing by increments of 5% to a maximum of 50%.
[illegible] 1918	For all buildings except warehouses and heavy mercantile and manufacturing buildings.	No reduction for roof load; load on top floor 90% of specified live load, for floor next below top floor, 85%; for each succeeding lower floor, correspondingly decreasing percentages down to a minimum of 50%; for the ground floor the full live load.
C. R. Young, 1920	For all buildings except those for which maximum floor loads are likely to occur on many floors at once.	No reduction for first column tier from top, load on second tier, 90% of total live load above, including roof load; for third tier, 85% of all live loads above, for other tiers, percentages diminishing by 5% per tier to a minimum of 50%

tributary to the column, is 72A, or 24 times as much as the area tributary to the girder "G." It is, therefore, self-evident that the reduction of live load for lower tiers of columns should be very great, since it is extremely improbable, and practically impossible, that anything like an area so great as 72A would ever be covered with the full specified live load.

Practically all building codes and building specifications make provision for some measure of reduction for live loads for columns. In Table II provisions for a number of representative codes and specifications have been set down, and in Table III a comparison of the actual loads on the various column tiers of an office building 20 stories high is made. In the case of the latter table, it is assumed that the live load on the roof is 40 lb. per square foot, and that the live load on all floors is 75 lb. per square foot, in order that the loading may fairly represent that specified in the existing building by-law of the city of Toronto. Of course it is assumed that the load specified for any floor will be determined by the use to which the floor is to be put; for instance, greater live loads would be specified for assembly or dance floors than for office or bedroom floors.

An examination of Table II will show that, as in the case of girders, it is generally provided that no reduction, or very little reduction, may be made for the columns of warehouses and analogous buildings. Certain codes, as those of New York, Minneapolis, Toronto, the National Board of Fire Underwriters, and specifications of C. C. Schneider, restrict the reduction rule to buildings over five stories in height. For this there does not seem to be any logical basis, since it is very unlikely that full maximum load on all floors of a 4-story [illegible], for example, would be attained at one time. It is the writer's opinion, consequently, that for buildings where a reduction rule is permissible at all, it should be applicable to buildings of any height in excess of one story.

Illogical and Extreme Rules. The form in which reduction rules are stated has been greatly influenced by the earlier building codes of the city of New York, in which reduction was made by a progressive scaling down of the floor loads from the top of the building to the lower levels. It thus [illegible] that under clauses of this kind the floor load for col- [illegible] was taken in the case of the top floor at 100 per cent of the specified value for beam design, whereas on the 11th floor from the top it was taken at only 50 per cent of

TABLE III—COMPARISON OF REDUCED LIVE LOADS ON COLUMNS OF OFFICE (AND SIMILAR) BUILDINGS, DETERMINED BY TYPICAL BUILDING CODES AND SPECIFICATIONS.

Assumed area carried by column at one floor (one-quarter of tributary area for typical interior column) = 100 sq. ft.

No. of floor from top.	Load, lb. per sq. ft.	Total load from top, lb. per sq. ft.	New York, 1917, Minneapolis, 1920, Toronto, 1913, 1920.	Chicago, 1911.	Boston, 1919.	Philadelphia, 1918.	American Concrete Inst., 1920.	Schneider, 1910.	Fleming, 1920.	Young, 1920.
			Total net load in lb. per sq. ft. of area carried by column at one floor							
Roof	40	40	40	40	40	40	40	40	40	40
1	75	115	115	104	115	89	98	115	108	104
2	75	190	186	164	143	138	152	183	172	161
3	75	265	254	220	159	180	199	243	232	212
4	75	340	318	273	170	218	238	295	288	255
5	75	415	378	322	187	253	270	340	340	290
6	75	490	434	367	196	282	294	378	389	318
7	75	565	486	408	226	310	311	408	434	339
8	75	640	535	446	256	333	320	430	475	352
9	75	715	580	484	286	353	357	445	512	358
10	75	790	621	521	316	372	395	453	550	395
11	75	865	659	559	346	386	432	490	587	432
12	75	940	696	596	376	398	470	528	625	470
13	75	1,015	734	634	406	407	507	565	662	507
14	75	1,090	771	671	436	414	545	602	700	545
15	75	1,165	809	709	466	419	582	640	737	582
16	75	1,240	846	746	496	422	620	678	775	620
17	75	1,315	884	784	526	421	657	715	812	657
18	75	1,390	921	821	556	421*	695	752	850	695
19	75	1,465	959	859	586	421*	732	790	887	732

*The writer has assumed that it is not intended that the Philadelphia rule be applied to the point of reducing the live load for any given column tier below that for the tier above. A strict application of the rule would, for the live loads assumed in the above table, give decreasing total live loads below the 18th floor from the top.

that specified value. It is, of course, illogical to assume a heavier load on the upper floors of a tall building than on the lower floors. While, therefore, the method of reduction provided for in the New York code and in that of Minneapolis, Toronto and many other cities, may give reasonable results, provided the percentage increments are properly chosen, the basis of the rule is illogical. Any rational rule should provide for a reduction of all live loads above, counting not only those on all the floors but in the cases of the second and subsequent tiers, on the roof as well, to represent the rapidly diminishing probability of full simultaneous live loads on all areas above. The rule should not be based as in the case of New York, Minneapolis and Toronto, on the increasing reduction of floor live loads.

From Table 3 may be obtained not only the total live load on all combined areas above the column tier in question per square foot of horizontal projection, but also the reduced live loads, according to various specifications for every column tier for a building 20 stories high. In Table IV the ratios which these reduced loads bear to the total loads above are given in percentages. It is seen from this table that whereas the New York, Minneapolis and Toronto codes require a column tier between the 11th and 12th floors from the top to be proportioned for 76 per cent of all possible live loads above, the other codes and specifications tabulated require considerably smaller percentages, and in the case of Boston as low as 40 per cent. The severity of the New York, Minneapolis and Toronto codes in this regard is well indicated when it is remembered that many building codes permit a reduction of live load on girders of as much as 20 per cent, although the area to be loaded to produce the maximum load on the girder would be only 1/24 as much as the area to be loaded to produce a maximum load on the column tier in question. Considering the observation of Blackall and Everett, to which reference has been made above, it does not seem necessary to provide for more than 50 per cent of all live loads above on column tiers below the ninth from the top, since in the investigations mentioned the maximum average load for all floors amounted to about 42 per cent of the maximum load observed on any one floor.

Suggested Reduction for Columns.—Based upon a study of the figures given, and of others not here presented, the writer would suggest the following specifications for reduction of live loads on columns:

For all buildings except those in which maximum floor loads are likely to occur on many floors at once as warehouses, storehouses and industrial buildings, the live loads on columns may be reduced as follows: For the first column tier from the top there should be no reduction, for the second tier from the top the load may be taken as 90 per cent of the total live load above including the roof load; for the third tier, 85 per cent of all live loads above, and for other tiers, percentages diminishing by 5 per cent per tier to a minimum of 50 per cent.

The reduction of all live loads above the second tier from the top by 10 per cent was arrived at on the assumption that not over 85 per cent of the area tributary to the column on the top floor should be considered as being covered with the full specified floor load, since a 15 per cent reduction of live load for girders is reasonably made for all floors. If, for the usual ratio of floor loads to roof load in such buildings as office buildings, the full roof live load be added to 85 per cent of the live load on the top floor, the sum will be found to be about 90 per cent of the sum of the full live loads above the second tier. The sum of the full roof live load and of 80 per cent of the full live loads on the first and second floors from the top would be about 85 per cent of the total live loads above the third tier. Similar percentages, diminishing by 5 per cent per tier, may be found for the remaining tiers. It is not generally considered advisable for the present, however, to proportion any column tier for less than 50 per cent of the sum of all possible live loads above.

TABLE IV—PERCENTAGES OF TOTAL SPECIFIED LIVE LOAD ON ALL FLOORS AND ROOF ABOVE FOR SUCCESSIVE COLUMN TIERS

With roof live load = 40 lb. per sq. ft., and floor live load = 75 lb. per sq. ft.

No. of floor from top.	New York, 1917, Minneapolis, 1920 Toronto, 1913-1920	Chicago, 1911	Boston, 1919	Philadelphia, 1916*	American Concrete Inst., 1920	Schneider, 1910.	Fleming, 1920.	Young, 1920
Roof	100%	100%	100%	100%	100%	100%	100%	100%
1	100	90	100	77	85	100	94	90
2	98	86	75	73	80	96	91	85
3	96	83	50	68	75	92	88	80
4	94	80	50	64	70	87	85	75
5	91	77	45	61	65	82	82	70
6	89	75	40	58	60	77	79	65
7	86	72	40	55	55	72	77	60
8	83	70	40	52	50	67	74	55
9	81	68	40	49	50	62	72	50
10	79	66	40	47	50	57	70	50
11	76	65	40	45	50	57	68	50
12	74	64	40	42	50	56	66	50
13	72	63	40	40	50	56	65	50
14	71	62	40	38	50	55	64	50
15	69	61	40	36	50	55	63	50
16	68	60	40	34	50	55	62	50
17	67	60	40	32	50	54	62	50
18	66	59	40	30	50	54	61	50
19	66	59	40	29	50	54	61	50

*Assumed area carried by column at one floor = 100 sq. ft.

Contractor Has Complete Dispensary on Construction Job

Lost time and compensation costs were greatly reduced by the maintenance of a complete dispensary on a construction job of the Thompson Starrett Co. at Cleveland, O. This particular feature is described by Dr. Herbert L. Davis in the Dec. 20 National Safety News.

The Thompson Starrett Co. secured the services of two industrial surgeons at Cleveland and equipped a dispensary on the job which compares favorably with any modern permanent dispensary. Every man, from the superintendent down, who receives an injury, no matter how trivial, reported to the dispensary at once. Safety bulletins advising the importance of early treatment of scratches and puncture wounds were posted conspicuously all over the job. As a result of this system there have been no disastrous accidents; there has been little compensation to pay; there has not been a serious infection; there has not been a case of lockjaw; there is not a cripple on the list.

The dispensary is equipped to take care of any emergency work. A registered nurse is in charge during working hours. One of the two surgeons makes one or more daily calls at the dispensary and both are subject to call at any time for serious cases.

With an average of 1,000 men on the job there were during five months, 820 examinations following accidents and 1,266 subsequent treatments. There were 140 puncture wounds and four fracture cases. Out of the 820 cases treated it is significant that there were only 14 infections, or 1.7 per cent of the total, which emphasizes one particularly important advantage of immediate treatment of all injuries, large or small. Seventy foreign bodies lodged in eyes were reported, 12 cases of conjunctivitis; 9 burns; 1 amputation, a toe; 2 dislocations, a thumb and a shoulder. There were in all only 27 lost time cases, and only 10 cases where compensation had to be paid, the total mount of compensation being only $191.14.

Personal Error in Measurement of Sieves.—Owing to a question raised by a sieve manufacturer as to the diameter of wire of certain sieves, an investigation of personal error and of methods of measurements of wire was made by the U. S. Bureau of Standards with several interesting results. The method of setting two parallel cross hairs in the micrometer microscope so that the edge of the wire is midway between them, was used in the case of these sieves, and five observers each made a series of observations with the result that personal error was quite evident. This merely confirms the more or less well-known metrological principle that it is difficult to match an equal width of bright and dark space.

Confidence and Production the Need of the Construction Industry*

By B. F. AFFLECK

President Universal Portland Cement Co., Chicago, Ill.

To account for the present inactivity in the construction industry it is necessary only to recount briefly some of the occurrences that have affected the industry in the last year or two.

Before the signing of the armistice the construction industry was hampered by war restrictions. After the armistice these war restrictions were removed but many of those interested in construction work hesitated to go ahead until conditions generally had settled on a reasonably firm basis. The result of both these factors was a large accumulation of work waiting to be done, the most important items, perhaps, being dwelling places and highways. In midsummer of last year activity was resumed and the demand for labor and building materials reached its height in the early months of 1920. By July 1 the demand for labor and materials for new projects had begun to recede because of obstacles in the way of prosecuting the work. These included high money rates, restricted credits, high prices for labor and materials, difficulty in securing materials because of curtailed production and, perhaps most serious of all, inadequate transportation.

In addition to the other difficulties retarding building, a disposition apparently growing out of war restrictions has continued to curtail through credit and the use of railroad cars that part of the nation's construction program that might otherwise have been carried out. The New York Times on Sunday, Sept. 26, 1920, in an article signed by Allen E. Beals, referred to "the notorious No. 7 Service Order, which when the companies protested against its enforcement so rigidly as to exclude all limestone from cement plants, even to the point of forcing mill shutdowns recently, was answered by the assertion that if further complaints were heard it would be applied so as to make it even more rigorous." The article states further, "Had this order not been promulgated there would have been produced some 7,000,000 more barrels of cement at the then mill operating rate of 70 per cent of capacity and much of the present stress for cement supply would have been avoided and building would have been much further along."

The order referred to is Interstate Commerce Commission Service Order No. 7, which successively under Orders No. 9, 15 and 20 has been extended indefinitely, and restricts open top cars with sides of less than 38 in. in height largely to the movement of coal, causing curtailment of the movement of building materials and other materials used in the manufacture of building materials.

As a result of the obstacles named, and others, there is still a large accumulation of construction work waiting to be done, and reports from architects' offices and other sources are that a great deal of work is being held at the point of preparedness ready to go ahead with the disappearance or alleviation of some of the retarding influences.

Improvement Already Noticeable.—Happily improvement is already noticeable in some directions. The railroad situation which has been probably the most troublesome factor in the situation, is much better than some weeks ago. Labor is available and equally important, it is increasing in efficiency, although wages are still high. These two circumstances alone will go far toward improving other factors. Better railroad operation will make possible the movement of farm products and other materials, thus releasing money now tied up, and at the same time will increase production which is the fundamental requirement of prosperity.

Such difficulties as the car shortage and the switchmen's strike, as well as others mentioned, offset not only outgoing shipments from manufacturing plants, but also production at these plants by interrupting the supply of coal and raw materials and by curtailing the switching of cars in yards necessary to the operation of the plants, and curtailed production, of course, means higher cost of production with resultant higher prices.

Using cement as an example, the difficulty in this year of unusually heavy demand has been not lack of manufacturing capacity but inability on the part of the manufacturers to keep their plants operating at capacity. The curtailment in cement production was caused by strikes and scarcity of labor at cement plants, strikes in other lines of industry, on which the cement plants are dependent, such as strikes in the gypsum plants, the strike of coal miners last fall, the strike in the Illinois-Indiana coal fields in July, the strike of railroad switchmen which extended through the greater part of this year, and the general lack of transportation facilities, including embargoes on the railroads.

The ratio of cement production to manufacturing capacity for the entire year 1919 was only about 54 per cent, and for the first nine months of 1920 about 67 per cent. The rated capacity of all cement mills in the United States is about 125,000,000 bbl. annually. The most cement ever used in the country in a year was about 94,000,000 bbls. in 1916. That is to say, the country has never used as much as 75 per cent of its productive capacity, conservatively estimated.

How One Cement Company Handled Deliveries.—In the case of the cement company operated under my direction, our difficulties date back to Aug. 1, last year, since which time strikes have interfered seriously with our mill operations. As a result, some jobs for which we could have supplied cement and which might have been completed last fall, carried over into this year. The year opened with an extraordinary heavy demand so that by Feb. 1 our mills were about 2,300 cars behind on shipments, and about March 1 this figure had grown to 3,600 cars. The peak came in the first week in May when we were about 6,100 cars behind, the oldest order dating from January.

The direct cause of these delays was the acute car shortage which was continuous over the first half of the year. There were times early in the year when our cement bins were taxed to capacity, making it necessary to adopt unusual means of delivery to make room for continuous operation of our mills. One of these means was the use of restricted railroad cars, privately owned cars furnished by customers and by ourselves, stock cars, open top cars which involved the use of tarpaulins to protect the contents, and bad order box cars. Cement, of course, under ideal conditions is shipped in box cars in good order, but this year we have had to take what we could get regardless of expense and inconvenience.

Use of restricted and privately owned cars, for instance, to some extent took the distribution of our product out of our own hands. We were offered at our Buffington, Ind., plant, one day by a certain railroad, a number of cars restricted to movement to Minneapolis and St. Paul. Aside from the fact that freight rates to the Twin Cities are much higher from our Buffington mill than from our Duluth mill, we did not want at the time these cars were offered us to move so much cement at one time into the Twin Cities, preferring rather to distribute it among a number of customers elsewhere whose needs were most urgent. Many times through the season we have received bunches of these restricted cars and have used them only because we did not have enough unrestricted cars to distribute our product equitably and to keep our loading and packing forces occupied and our mills going.

Another means adopted to keep our product moving was the use of motor trucks, involving, of course, additional expense to ourselves and our customers. From all our plants about 2,250,000 bbls. of cement were moved by truck for the nine months ending Sept. 30. The movement from our Chicago plant at Buffington, Ind., was just under 2,000,000 bbl. of which about 250,000 bbl. moved to team tracks of trunk lines that do not enter our mills, and more than 250,000 bbl. to a dock where the cement was loaded onto boats for transportation to lake ports. The extreme to which our Chicago plant went in truck deliveries is shown by the fact that as many as 613 trucks were loaded in a single day, the equivalent of about 120 cars. This was at the rate of more than a truck per minute.

Our truck deliveries to customers in the Chicago district have been about 1,500,000 bbl., the equivalent of 7,500 carloads of 200 bbl. each. This means that the cement requirements of Chicago this year have been more satisfactorily supplied than perhaps any other city in the country, and that about 7,500 railroad cars in a time of acute car shortage would have been required to accomplish the work done by trucks. It would seem unnecessary to advance any other fact than this as an argument for the construction of well paved highways and city streets. Truck traffic must be available to supplement railroad service, and trucks must have permanent roads to run on. The Chicago district has been fortunate in its cement supply and is assured of its supply next year to the extent that manufacturing conditions will permit. It can use trucks instead of cars if necessary, but this fact cannot overcome the effect of occurrences like the coal strike in the Illinois-Indiana fields last July which cost about 200,000 bbl. of production at our Chicago plant.

---

*Statement at hearing of U. S. Senate Committee on Reconstruction and Production, Chicago, Nov. 11.

It should be borne in mind that if all cement users in Chicago and elsewhere had been able this year to secure all the cement ordered by them it is very probable that they would have found themselves in the position of being unable to use all the cement so ordered. This means that so many factors were present to delay work, that the disappearance of one of these factors such as failure to get cement would not have eliminated the other factors. In other words, if a particular job had been able to secure all the cement needed it would not have been able to secure sufficient sand and gravel or stone; if these materials had been forthcoming there would have been a scarcity of or trouble with labor, and if labor had been available and efficient there would have been difficulty in securing credit to allow the work to proceed.

Production the Need of the Construction Industry.—The outstanding fact in the whole situation is that need for structures of many kinds is present throughout the country and must be filled sooner or later. The way for building activity will clear as soon as all or at least some of the obstacles mentioned begin to disappear. In other words, the crying need in the construction industry is production in its broadest sense, not only of building materials but of everything necessary to keep the industry going—transportation, labor, fuel, credits, confidence, and the last perhaps is greatest of all since the others will follow it. Confidence and production are needed, and lack of them simply adds in a greater or less degree to the high cost of living, and forms a part of the "vicious circle" that has been with us through these war and post-war times.

A further consideration, and a most important one, is that all effort, whether it be in the form of money, credits, materials, labor transportation or what not, that goes into construction work, unlike that going into work of many other kinds, is not consumed. At a time like this when owners, contractors and others may be discouraged from undertaking new projects, this thought should be given prominence. Effort that is being expended throughout the country on many things that are consumed might well go into construction work, where the materials and labor and other things involved are not consumed but transformed into houses, industrial buildings, improved highways, water power development and other valuable improvements that form additions to the permanent taxable wealth of the country as well as tools for production of additional wealth.

Income of College Graduates.—The average yearly income of members of the class of 1910 of Cornell University, according to statistics collected by Andrew Whinery, secretary of the class, is $5,385. The average incomes by professions is given in the Cornell Civil Engineer, as follows:

10—Bankers and brokers	$11,010
16—Manufacturers	8,521
18—Physicians	7,944
7—Architects	7,230
31—Merchants	7,136
20—Lawyers	5,905
41—Salesmen	5,690
3—Purchasing agents	5,600
4—Advertising	5,476
5—Newspaper	5,180
5—Accounts and statistics	5,004
6—Insurance	4,533
14—Farmers	4,461
15—Builders and contractors	4,287
7—Veterinarians	3,921
8—Engineers	3,721
33—Teachers	3,137
[illegible]52—Members of class	$5,385

Industrial Machinery in France and Belgium.—"Industrial Machinery in France and Belgium" has just been published for the benefit of American machinery manufacturers, engineers, and contractors interested in supplying the equipment necessary to rehabilitate the industries of the two countries so seriously affected by the war so that they can resume their former status in the peace-time markets of the world. Copies can be obtained for 10 ct. each from any of the District or Co-operative Offices of the Bureau of Foreign and Domestic Commerce, or from the Superintendent of Documents, Washington, D. C.

Pouring Tests of Concrete

In order to determine [illegible] satisfactory job of concreting could be secured [illegible] likely to exist in field work during the [illegible] ships the Bureau of Standards has [illegible] some very interesting tests.* To be [illegible] there should be no voids in the finished product, and [illegible] expected to have a smooth surface finish [illegible] should have strength commensurate with [illegible] be of uniform quality. The tests were [illegible] Emergency Fleet Corporation at the concrete laboratory of the Bureau of Public Roads, Arlington, Va., [illegible].

The pouring specimen used was a slab 6 ft. high, 6 ft. wide, and 4 in. thick, having a mass of reinforcement designed to reproduce conditions such as would occur in pouring the shell of a reinforced concrete ship. Figure 1 shows the reinforcement assembled and in position with one side of the form temporarily removed.

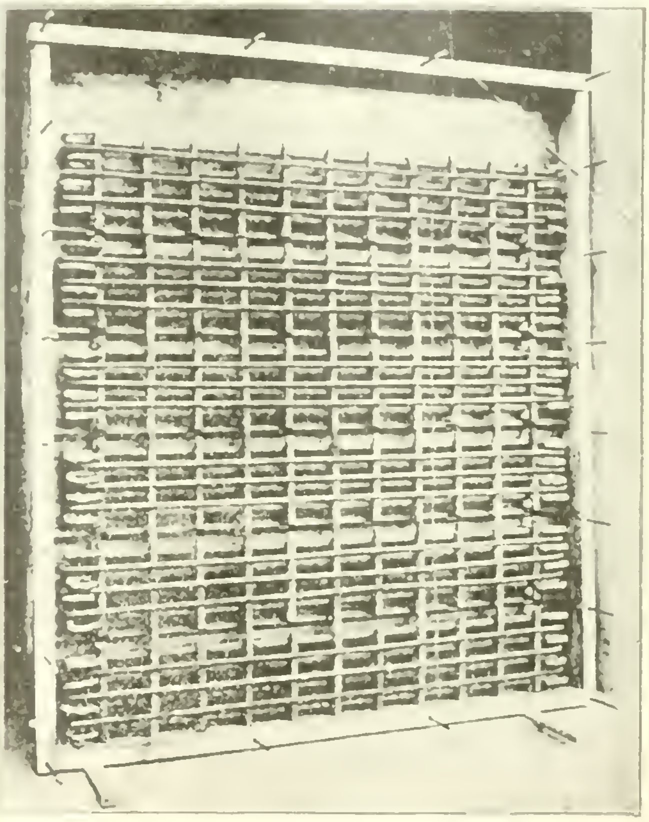


Fig. 1—Assembled Reinforcement and Form for Specimen Used In Pouring Test.

Wedge-shaped strips cut from $1\frac{1}{4}$-in. square stock were attached to both of the side forms horizontally at intervals of 12 in., marking V-shaped grooves along which the slab was later broken into sections for testing transversely. The wedge strips also served the purpose of choking the opening through which the concrete had to pass and therefore made pouring very much more difficult. The percentage of tension reinforcement was taken large enough to insure failure of the concrete in compression in the transverse tests of the slab sections, unless the strength of the concrete, as computed by the parabolic formula, should exceed 3,500 lb. per square inch.

An Austin cube mixer having a rated capacity of 1 cu. yd. per batch was used for mixing the concrete for this test. The concrete was proportioned by volume, using 1 part of a standard portland cement, $\frac{2}{3}$ part of Potomac River sand, and $1\frac{1}{3}$ parts of gravel. The gravel was graded in size from $\frac{1}{4}$ to $\frac{1}{2}$ in. The amount of water used in mixing was 12.5 per cent of the combined weight of the dry materials. The materials were weighed, and the proportions by volume, $1:\frac{2}{3}:1\frac{1}{3}$, were computed from the weights.

The cement and aggregate were mixed dry for about 30 seconds after which the water was added and the mixer was run for 1 minute and 4[illegible] seconds before [illegible] the first wheelbarrow load of concrete. It was generally 1 minute more or longer before the remainder of the batch had been removed from the mixer. At the best an appreciable amount of concrete remained in the mixer from one batch to the next.

---

*Technologic paper No. 175, "Pouring and Pressure Tests of Concrete," by W. A. Slater, Engineer Physicist, Bureau of Standards, and A. T. Goldbeck, Engineer of Tests, Bureau of Public Roads.

The concrete in the lower half of the form was placed in the form by means of shovels and [illegible] through an opening in the side of the form 10 in. [illegible] with its lower edge 2 ft. 1 in. above the base of the form. The location of this opening is indicated in Fig. 2 by the words "window pane." The form was vigorously pounded with heavy hand hammers throughout the pouring. Air bubbles were released by the pounding and rose to the surface of the concrete. The rising of air bubbles continued for a considerable length of time, and had not entirely stopped when pouring was completed and the pounding was discontinued.

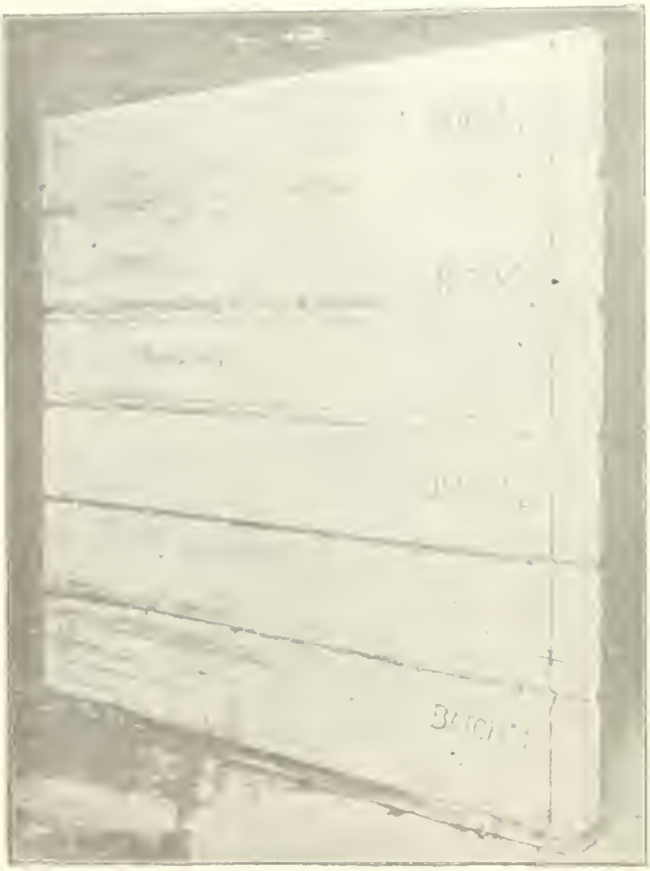


Fig. 2—Pouring Test Specimen Removed from Form.

Cylinders 6x12 in. were filled with concrete taken from the wheelbarrow as it was wheeled to the form. These molds were placed on a smooth floor and when filled were lifted at a uniform rate, as nearly vertical as possible. The diameter of the puddle thus formed was taken as a measure of the consistency. The same concrete was replaced in the molds and later the cylinders were used as test specimens for the compressive strength. Table I gives the consistency reading for these control specimens, and also the compressive strength when tested at the age of 31 days.

The concrete at the top of the slab was struck off even with the edge of the form in order to provide a means of measuring the amount of settlement during setting. Later observations showed that a settlement of about ½ in. had occurred in a total depth of 6 ft.

One side form was removed the second day after pouring in order to examine the surface of the specimen. This surface is shown in Fig. 2, and its appearance indicates that the pouring was satisfactorily completed. A smooth surface was obtained at all points on the face of the slab. Even under the wedge-shaped strips used to separate the individual slabs only one place was observed where a perfect filling was not obtained. This imperfection was so slight, however, that it is not noticeable in the photograph.

Strength Tests.—It was desired to see if any variation existed in the strength of the concrete caused by differences in position in the specimen. Accordingly the specimen was divided into shallow beams for testing separately under transverse loading. A large amount of steel was used for tension reinforcement, with the intention of forcing failure by compression in the concrete. In spite of that provision all of the specimens failed in tension, and the full strength of the concrete was not developed.

Six sections were made by dividing the specimen into beams 12 in. wide and 6 ft. long. This separation was made at an age of about 3 days by breaking the slab along the lines of the V shaped grooves shown in Fig. 2. The beams were numbered from 1 to 6, inclusive, starting with the bottom of the specimen as poured. They were stored under wet burlap and were tested at an age of 31 days.

The reinforcement in each shallow beam consisted of 4 ⅝-in. square bars in the bottom and 3 ½-in. plain round bars in the top. The top and bottom layers of reinforcement were separated by 11 transverse ¾-in. square spacing bars 12 in. in length. The amount of bottom reinforcement varied from 4 to 4.7 per cent on account of the variation in thickness caused by uneven spreading of the form during the pouring. The beams were tested on a span of 5 ft. 6 in., with the load at two points 12 in. apart and each 6 in. from the center of the span. All bearing blocks were bedded in plaster of paris. Deflections were measured at midspan by means of an Ames dial reading to 0.001 in.

The measured thickness of the sections into which the slab was divided was greater than the nominal dimension of 4 in., indicating that there was a slight bulging of the forms due to the pressure of the concrete.

The compressive stress in the concrete at the maximum load, as computed by the parabolic formula, exceeded the assumed value of 3,500 lb. per square inch, and none of the shallow beams failed by compression in the concrete. Table II gives the results of the beam tests.

The computed compressive stress in the concrete of the shallow beams at the maximum load was greater than the strength of the control cylinders, even though the ultimate strength of the concrete in the shallow beams had not been reached. The average strength of the control cylinders was 3,670 lb. per square inch. The average computed compressive stress developed in the beams at the maximum load was 4,400 lb. per square inch by the parabolic formula and 6,075 lb. per square inch by the straight-line formula. The ratios of the computed flexural stress at maximum load to the cylinder strength were 1.20 and 1.66 for calculations by the parabolic and the straight-line formulas, respectively. These ratios are consistent with results found in previous tests.†

Summary of Tests.—(a) The test indicated that with the gravel aggregate used it was practicable to obtain a smooth dense surface, such as is required in the shells of concrete ships, in spite of the narrow and constricted space between forms and the obstruction of the reinforcement.

(b) In the pouring test the maximum compressive stress developed in the concrete in flexure gave computed values averaging 66 per cent higher than the ultimate compressive strength of the concrete as determined by tests of control cylinders.

(c) The quality of concrete obtained by pouring into forms which were well pounded during the pouring was quite uniform, the maximum loads and computed stresses obtained in flexure tests of shallow beams made from the pouring test specimens were reasonably consistent.

(d) No variation in the strength of the beams due to differences in position in the pouring test specimen was determinable on account of the fact that none of the failures occurred by compression.

(e) The factors of safety against compression failure are

TABLE I—CONSISTENCY AND COMPRESSIVE STRENGTH OF CONTROL CYLINDERS.

(Water 12.5 per cent of combined weight of dry materials.)

Cylinder No.	Batch No.	Barrow No.	Consistency reading.* In.	Maximum load Lb.	Compressive strength. Lb. In.²
[illegible]	[illegible]	[illegible]	16¾	10[illegible],940	3,670
[illegible]	1	[illegible]	6	.....	.....
[illegible]	[illegible]	[illegible]	13		.....
4	[illegible]	[illegible]	14[illegible]	102,570	3,620
[illegible]	[illegible]	1	12¾	.....	.....
[illegible]	[illegible]	2	11	9[illegible]	3,350
[illegible]	4	1 and 2	1[illegible]	11[illegible]	4,030

*The [illegible] reading is the diameter of the puddle of concrete [illegible] after [illegible] the [illegible] cylindrical mold.

†Th[illegible] made from [illegible] hand-mixed batch just large [illegible] for [illegible] prior to starting the pouring test.

---

†Slater and Zipprodt, Compressive Strength of Concrete in Flexure, Proc. Amer. Concrete Inst.; 1920.

TABLE II—RESULTS OF SHALLOW [illegible] TESTS

Beam No.	Measured thickness. In	Depth to tensile steel.* In	Tension reinforcement Pct	Maximum load. Lbs	Deflection at maximum load In	Compressive stress at maximum load: Parabolic formula Lbs in.²	Compressive stress at maximum load: Straight-line formula	[illegible]	Ratio computed stress at maximum load to working stress: [illegible]	Ratio computed stress at maximum load to working stress: Tension‡
1	4.13	2.[illegible]	4.7	10,[illegible]	0.[illegible]	4,400	[illegible]	[illegible]	[illegible]	2.[illegible]4
2	4.60	2.[illegible]	4.4	12,5[illegible]	[illegible]	4,[illegible]	[illegible]	[illegible]	4.4	2.84
3	4.88	[illegible]	4.2	11,630	.58	4,080	5,[illegible]	[illegible]	[illegible]	2.51
4	5.19	3.25	4.[illegible]	1[illegible],240	.[illegible]8	4,240	6,[illegible]	[illegible]	[illegible]	2.72
5	5.13	[illegible]	4.[illegible]	12,430	.85	4,[illegible]	6,600	[illegible]	[illegible]	2.66
6	4.41	2.[illegible]	4.5	11,280	.91	4,620	6,2[illegible]	[illegible]	[illegible]	2.62

---

*The depth of tensile steel given assumes that the reinforcement [illegible] as originally placed in [illegible] bulged equally in both directions.

†In determining the ratio of the [illegible] stress at maximum [illegible] to the working stress the [illegible] was computed by the straight-line formula, taking [illegible] The working [illegible] was 1,[illegible] pounds per square [illegible] was not counted as reinforcement as it [illegible] at the neutral axis.

‡The ratio of the tensile stress at [illegible] to the working [illegible] the factor of safety [illegible] in the reinforcement.

not known, as the beams failed by tension. It is apparent, however, that if sufficient reinforcement had been provided to prevent tension failure, the factors of safety against compression failure would have been found to be greater than the values in Table II, given as the ratio of the stress computed by the straight-line formula for the maximum load to the working stress.

(f) The working stress used in concrete ship design, 1,500 lb. per square inch in flexural compression, provides an ample factor of safety against compression failure with concrete of the quality used in these tests.

The Inspiring Outlook for American Engineering*

By MORRIS LLEWELLYN COOKE,
Consulting Engineer, Philadelphia

The hour of opportunity for the engineering profession really seems to have arrived. All the problems of our common life have come to be recognized as of a size and complexity requiring basic solutions. The public is apparently beginning to loose faith in shorts cuts and political expediency and will more and more demand social and economic readjustments based on a full understanding of all the facts and a thorough-going orientation of all the elements in any given situation. And there is clearly discernible throughout our profession a growing sense that somehow the engineering approach is what is needed if ordered progress is to be the watchword for a civilzation in the agonizing process of seeking new levels. Every day sees us ready to broaden our definition of engineering. To the fields of design and construction we are adding operation with ever increasing emphasis. In fact there is every reason to believe that our work in the field of the management of men—the engineering of men as contrasted with the engineering of materials—is the one thing which is elevating our profession, placing it on a plane with the other professions which have dealings with men as distinguished from dealings with things. May we not look forward to a favored position among the professions in view of our dealings with both materials and men.

No one has stated this expansion in the scope of the field of our profession in a more illuminating fashion than Herbert Hoover, when, in speaking of the engineer, he said:

> "Unlike the doctor, he is not the struggle to save the weak. Unlike the soldier, destruction is not his prime function. Unlike the lawyer, quarrels are not his daily bread. Engineering is the profession of creation and of construction, of stimulation of human effort and accomplishment."

Such a job is certainly there to be done. Even if we have not been officially tagged or designated to do it we must admit that there is no other agency or division of society competing with us for the opportunity. It therefore resolves itself into a question as to our capacity to embrace an opportunity as splendid as it is obvious.

Given a job to do the wise workman first looks to his tools. What then should be included in the equipment of American engineering when launching forth on such a noble and ennobling task? The appointment in recent years (1) of Organizations and Aims and (2) Development Committees by various representative engineering organizations and the changes which are resulting from their activities may be taken as an evidence of a desire to so revamp individual organizations as to broaden their field of service and co-operate most effectively in bringing about engineering solidarity throughout the nation and ultimately throughout the world.

The Cause of Engineering Solidarity. The cause of engineering solidarity has been much advanced recently by the frank acknowledgment of public purpose as the goal of engineering as expressed in the Preamble to the Constitution of the Federated American Engineering Societies, which reads as follows:

> "Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of man, and the art of organizing and of directing human activities in connection therewith.
>
> "As service to others is the expression of the highest motive to which men respond and as duty to contribute to the public welfare demands the best efforts men can put forth, NOW THEREFORE, the engineering and allied technical societies of the United States of America, through the formation of The Federated American Engineering Societies, realize a long cherished ideal—a comprehensive organization dedicated to the service of the community, state, and nation."

American engineering solidarity must ultimately involve the working out of a scheme by which every engineering activity and every engineering organization—local, state, regional and national—is each given its logical place in a living and vibrant whole. One of the chief purposes of such an American engineering union should be to take a leading part in effecting international engineering solidarity. Work already done in adopting international standards suggests the illimitable field for international engineering co-operation with the public welfare as its motive.

Passing of the All-Round Engineer.—Obviously engineering solidarity will be impossible except as we break down the distinctions between men practicing in different branches of the profession. The throat and nose specialist, the gynecologist and the orthopedist find their work in different parts of the human body, but their tools and their technique and their science are largely the same. No medical profession would have been possible except through the recognition of the essential similarities in all medical and surgical work. The day of the all-round engineer has gone. It is really through the travail brought about by our widespread specialization that a genuine profession of engineering is being evolved.

All our current schemes of organization of engineering bodies—our management, administrative and directive methods—are really very crude, permit much duplication of effort and anxiety over nonessentials. In the light of its historical development perhaps it could not be otherwise. But in view of the fact that management and its allied activities are now a recognized part of engineering it behooves us to study the problems of our own organizations. We should be a model in this respect for other social agencies.

Character of the Engineer's Task. And now let us discuss very briefly what is to be the general character of this inspiring task which lies before our profession. In a word, is it not the complete fulfillment of our obligations to science and to humanity? To accomplish this we must, of course, keep on doing in ever-increasing measure the same high grade technical work the doing of which in the past has given us our present position. But no matter how thorough and painstaking our technical work may be nor how much real genius we bring to bear on it, it will not fully answer the expectations of our time. Where in the past we have more or less drifted to our results we must now lay out and consolidate our field of action and sweep on to wider and deeper solutions not only by predetermined met[illegible] but by predetermined time schedules. We must introduce into engineering something akin to the vaulting elan [illegible] in the work of any great artist.

---

*From an address, Oct. 19, before the Engineers' Club of Philadelphia.

The Engineer's Responsibility. The [illegible] of our engineering attack on world problems is terrific. [illegible] Here and there we have pushed our defenses [illegible] country. [illegible] at myriad points our [illegible] and wastefulness are so serious as to invite disaster [illegible] in a reasonably steady line of engineering advance [illegible] our responsibility. The great fact to be remembered [illegible] gladly accept it and thank God for all the [illegible] opened up. It has just dawned on us [illegible] our coal mines are only working 200 days in the year and further that on the days when they do [illegible] the output per individual is conservatively estimated at [illegible] that common in metal mining. Herbert Hoover has recently characterized coal mining as "the worst functioning industry in the country." Some of our best engineering minds are now sifting out the facts in the situation. I have no hesitation in predicting immediate and revolutionary improvements in methods of getting coal, many of which have remained unchanged for over 100 years.

In conclusion I would direct your attention especially to three or four aspects or attributes which all engineering must take on if, as a profession we are to play a major role in the Great State now being forged out of a world's agony and turmoil.

First we must see to it that engineering is democratized in the sense that art has been. It must be brought to or within reach or control of the people, to quote the dictionary. We must seek out all the ways in which the man on the street with a thousands interests can be made to feel a sense of satisfaction—even proprietorship—in engineering advance. We engineers must avoid building up a cult and looking upon ourselves as a class apart. On the contrary we must individually more and more seek to widen our contacts with all the pulsating life of our times. Let us study the technique of reaching the people through non-technical publications and throw open our engineering laboratories, libraries and halls to the widest possible public use. Let us seek to have engineering grow up, as it were, out of the necessities and desires and life of the people.

Cultivation of Aesthetics. Again, I need not tell this audience that nothing can be truly great unless it is beautiful. And so as my second point, I suggest the cultivation of aesthetics as a feature of every branch of engineering. Sometimes in a sinister mood we associate noise and ugliness and even filth with accomplishment, with "getting things done," as we say. But it is all like a bad dream. It is not true. Largely because we need the influence of their love of the beautiful I hope we can get closer and closer to the architects so that ultimately we may find ourselves one profession. For this reason we engineers should all be profoundly grateful that the American Institute of Architects was one of the first organizations to join the new Engineering Federation. We have come to recognize beauty as an element in some of the work of the engineer. Some of our recent bridge work has really been quite inspiring. But think of the room for improvement in the average industrial establishment!

Introduction of Romantic Quality. And then, we must more and more resent the imputation that because we engineers try to be reasonably sure of our facts engineering itself must necessarily be either dull or prosaic. On the contrary, we begin to see that engineering may have a romantic quality—indeed, that all great engineering work must have it. In an article in the October Atlantic, the later Francis B. Gummere, professor of English at Haverford College, defines romance as "the audacious but not irresponsible treatment of fact" and again as "the control and combination of facts by imagination and hope." Perhaps we engineers have too frequently sought to combine and control facts without the aid of imagination and hope. But we do not have to persist in this error. And will not this best of worlds be even better when our engineering becomes tinged with romance as Professor Gummere has defined it?

Spiritual Values. And finally, if we are planning a profession which shall largely affect progress in God's universe, we must introduce something akin to spiritual values into engineering. Nothing short of this will give us real leadership in a world where nothing but moral values really count.

Closed or Open Shop Policy for Construction Labor?

By CHAS. F. DINGMAN.

Sooner or later every organization engaged in building construction finds itself confronted with this question, "Shall we employ union labor?" By this I do not mean that they must decide whether they will permit one or more union men to work in the organization, but that they must decide definitely whether the labor policy shall favor the unionization of the entire organization or whether they will adhere to a strictly open-shop policy.

This question is much more complicated than it seems to be at first sight and there are many factors which must be considered. For instance, the territory in which the organization intends to solicit business may be the governing factor in determining its labor policy. There are many sections of the country, notably a very considerable portion of the state of Connecticut, in which it is absolutely futile for a construction company operating upon a strictly closed-shop basis to solicit contracts from the larger manufacturing plants.

This is not because they must figure to charge higher prices for their work; I have attended openings of bids where the numbers of open-shop and closed-shop bidders were about equal and the bids showed the same range as if all were closed-shop bidders; it is because the manufacturers in that section are all strongly opposed to the employment of union labor on their work.

There are also a great many manufacturers who, while not definitely opposed to union labor, have a very strong preference for the open-shop basis and the representative of any closed-shop organization finds himself called upon to show what actual advantage for the client, if any, is gained by adhering to the closed-shop basis.

Though I am strongly opposed to the lump-sum bid as a means of securing business, lump-sum bids, when publicly opened, have one good feature, and that is that they give the several bidders an occasional opportunity to compare their bases of figuring with that of their competitors. And, as I have stated above, lump-sum bids submitted upon a great variety of work fail to disclose any advantage to either side, sometimes the low bidder will be an open-shop concern, sometimes a closed-shop concern.

It might even be thought that an open-shop concern would probably be paying lower wage rates than the closed-shop organization would. Yet, I have never found anything to bear this out. I have heard of small shops, employing only a few non-union men, where the rate was apparently lower than the prevailing union rate but it usually develops that these men are kept on the year around, whether times are busy or slack, and so they actually receive a higher income than their more casually employed union friends.

In fact, I have talked with representatives of some fairly large organizations who do business on an open-shop basis, and I have yet to meet one who claimed that he was able to employ non-union men at a lower cost per unit of work produced than that at which he could have employed union men. In most cases I was told that, because of not having the union as a reservoir to draw upon for additional men when needed, it was necessary to pay wages equal to the union rate and to find some means of keeping the men on the pay-roll all of the time.

Of course, in times when there is more than enough work to go around, the union rate really becomes the minimum rate for the least competent and the more competent men, whether union or non-union, will demand and be offered a higher rate. It is then that the union fails to perform its function as a reservoir for additional men. When work is plentiful as compared to the number of men available, as during the season just passed, we find employers bidding against one another for men and the union rate ceases to have anything but a nominal significance, the point from which the rate starts its upward climb, as it were.

Then, too, the production of work per man begins to diminish and the men begin to lose a sustained interest in their work. When anyone can get a job at any time, a job is not such a valued possession as at other times, and the shortage is thus still further aggravated. It doesn't matter much then which basis you are working on, if you need men the only way to get them is to hire them away from some competitor who happens to be working on the same basis as you are and to meet the offers of the man who tries to hire them away from you. Of course, in the well organized trades, union men and non-union men won't mix.

If, then, non-union labor cannot produce work more cheaply than union labor, why is there such a strong preference for the open-shop on the part of many men all over the country and such a determined opposition to union labor in certain sections? This feeling is so strong that there are some of the very large building organizations who do business entirely upon the open-shop basis and who make that one of their selling points when soliciting contracts.

It is nothing but the desire to be in control of a situation. It is the feeling that the union and not the employer will dictate the method of conducting the work, and that the interests of the union will receive preference over those of the client.

Of course, on an open shop job there is no union to be considered at all, but when men are scarcer than jobs, it does not matter much, anyway; the same tendency to get as much as possible and to give as little in return will manifest itself in either case. And it is also true in such times that the union officials, from the sheer necessity of preserving their own functions, would be constrained to hold the men in check as much as possible, while no such restraining influence would exist among non-union men. Union officials realize that their salvation lies in their ability to induce the membership to keep and live up to the agreements which the officials make.

In ordinary times, however, there is always a greater or less surplus of men over jobs and there are always places where this surplus is comparatively large, while in other places an actual shortage of men exists. It is then, if ever, that the conflict of interests between the union on the one hand and the employer and client on the other hand takes place. Of course, the interest of the union is primarily to keep its entire membership employed at the union rate at all times and, naturally, each local union seeks to enforce the employment of its local membership in preference to outsiders.

The interest of the employer or client is, conversely, only to employ as many men as are necessary for the efficient conduct of the work and, of course, to choose those men who are believed to be most likely to deliver the greatest volume of work per dollar of wages.

When no union is in control of the situation, the only factor which need govern the employer in handling the employment question is the relative supply of and demand for the different classes of men needed. If a surplus of men of any trade exists conditions of employment may be made more stringent and a greater production demanded; if there be a shortage of such men, the conditions may be made more lenient or, what is usually impracticable under union conditions, an attempt may be made to break in new men and teach them sufficient of the rudiments of any trade to enable them to fill the gap. In this case their rate of pay would bear some relation to their acquirement of proficiency.

With the conditions of employment entirely in the hands of the employer, as long as a sufficient supply of men is available, the tendency is to discharge men as soon as the need for their services ceases and to employ them again only as needed. This would seem entirely practicable if experience had not already demonstrated that the men thus discharged are very likely to drift off into other forms of employment and not be available when needed again, then their places must be filled with new men who must be taught all over from the beginning. This has developed the necessity, previously mentioned, of finding some means of keeping all moderately valuable men on the payroll at all times. In many industries this might be no problem at all to the employer, but in building construction, which is subject to so many varying conditions, it may often be necessary to take unprofitable contracts in order to carry men who may be needed in the future.

Aside from the fact that union officials are sometimes inclined to arrogance and that union rules are often onerous to the employer, that jurisdictional disputes have often made the employer the "goat" during inter-union quarrels, there are many building organizations which have concluded that they can give their clients better service by operating on a union basis. This is just as true of concerns operating over wide stretches of territory as it is to those operating in particular localities.

In fact, the concern operating locally need ordinarily only consider whether the trades in the place where it operates are well organized or [illegible] policy, while the organization operating over a large territory must be prepared to convince [illegible] everywhere that it has chosen the wiser policy.

The outstanding reason [illegible] employers to relinquish the so-called [illegible] and to deal with labor unions instead [illegible] is that the greater number of the best mechanics in all the building trades are union men. I do not mean to say that there are not just as good men out of the unions as in them, but there are not as many good men outside.

Another reason is that, in normal times, the unions do perform their function of a tank or a reservoir. When a man is laid off at one job, he is not more or less permanently detached from the trade but is available through the union office for any other employer who needs him and few employers would feel called upon to carry him on the payroll just to be able to get him again when needed.

Then, too, most trades which are organized at all are so organized that practically the same rules govern any particular trade in all parts of the country, and a concern, operating on a union basis, can go into almost any section and pick up the men which it needs there and employ them under practically the same conditions as in its own town. I am aware that in certain districts there are agreements between building trades employers' associations and the unions that are intended to hamper out-of-town concerns who attempt to come in, but these are comparatively few and are mostly confined to very large cities.

Of course, when you employ union men you must pay the poorest man on the job the full rate, and the chances are that if you pay the better men a premium, you will have to raise all of them to the premium rate. However, the very fact that the union has established a scale of rates, usually by agreement with the employers' association, gives that scale a definite standing as the basis and practically assures any employer that, unless employers start bidding against one another for men, each will purchase labor power on the same basis as all others and removes just one more factor of uncertainty from the business.

United States Has 105,708,771 Population. Final figures for the 14th census, announced Dec. 17 by the Census Bureau, show that on Jan. 1, 1920, the United States had a population of 105,708,771. The figures by states are as follows:

Alabama	2,348,174	Nebraska	1,296,372
Arizona	333,903	Nevada	77,407
Arkansas	1,752,204	New Hampshire	443,083
California	3,426,861	New Jersey	3,155,900
Colorado	939,629	New Mexico	360,350
Connecticut	1,380,631	New York	10,384,829
Delaware	223,003	North Carolina	2,559,123
District of Columbia	437,571	North Dakota	645,680
Florida	968,470	Ohio	5,759,394
Georgia	2,895,832	Oklahoma	2,028,283
Idaho	431,866	Oregon	783,389
Illinois	6,485,280	Pennsylvania	8,720,017
Indiana	2,930,390	Rhode Island	604,397
Iowa	2,404,021	South Carolina	1,683,724
Kansas	1,769,257	South Dakota	636,547
Kentucky	2,416,630	Tennessee	2,337,885
Louisiana	1,798,509	Texas	4,663,228
Maine	768,014	Utah	449,396
Maryland	1,449,661	Vermont	352,428
Massachusetts	3,852,356	Virginia	2,309,187
Michigan	3,668,412	Washington	1,356,621
Minnesota	2,387,125	West Virginia	1,463,701
Mississippi	1,790,618	Wisconsin	2,632,067
Missouri	3,404,055	Wyoming	194,402
Montana	548,889		

Decarburization of Steel by Heating in Vacuo. Tests at the U. S. Bureau of Standards are summarized as follows in a Technical News Bulletin of the Bureau: Specimens have been heated in vacuo for periods as long as 24 hours at approximately 760° C. The carbon content of the material was reduced from 0.52 per cent to 0.36 per cent. Previous work described in Scientific Paper 356 has shown that a very appreciable surface decarburization occurred in specimens of low carbon steel after 30 minutes at 760° C. This material was iron carbon alloy prepared at the Bureau to which no additions other than carbon had been made. The explanation suggested for the loss of the carbon in vacuo at high temperatures assumes the presence of oxygen in some form. Commercially prepared steel (metal which has been deoxidized) behaves very differently from the small melts made in the Bureau's experimental foundry without deoxidation treatment, thus substantiating the validity of the assumption made, that 30 minutes' heating in vacuo at 760° C produces no appreciable change in "commercial" steel—several hours are required to reduce the carbon content to any extent. The investigation will be continued.

Deteriorating Effects of Acids Upon Concrete

With a view to clearing up many contradictory statements and notions with regard to the effect of acids upon concrete, a series of tests was made by the German Concrete Association (Deutscher Beton Verin), and the results compared with available data on this subject. The report, according to an article by C. A. Heise, Berlin, in the November Concrete, corrects many erroneous views formerly held.

According to the report by the Research Committee it may now be definitely stated that practically all acids have a disintegrating effect upon concrete and that the period of the process of disintegration is in direct proportion to the heat temperature of the respective chemicals.

As regards salt and saliferous water no hard and fast rules can be laid down, while the effect of acid solutions and acidiferous water does not merely depend upon the concentration of acid, but also varies with the different kinds. Some of the worst enemies of concrete were found to be nitric acid, hydrochloric acid and acetic acid, due to their tendency to combine with oxide of calcium, thus producing soluble calcium salts. On the other hand, it was shown that sulphuric acid, sulphurous acid, hydrofluoric acid and other acids were comparatively less dangerous. Extensive experiments have proved that the process of disintegration caused by the latter is less intensive and more retarded on account of the insoluble calcium salts resulting from the chemical action of the acids which produce a sort of protective coating. It is also interesting to learn that while dry sulphuric acid vapors of a low temperature failed to produce any deteriorating effects, disintegration of concrete when subjected to wet vapors of a high temperature was complete within a short time.

Even milk was shown to possess destructive properties, penetrating into the finest pores it tends to produce acidifying effects, while as regards the action of muriatic acid vapors there are many contradictory statements.

Reports from tanneries using chromium are emphasizing the serviceableness of concrete in every respect, but sugar and benzine are its sworn enemies. Contrary to the notions of many engineers and others it has been ascertained that carbon alkalis, such as carbonate of potassium, carbonate of sodium, carbonate of ammonium, do not attack concrete and chloride of calcium, potassium nitrate and sodium nitrate are likewise considered to produce no deteriorating effects.

On the other hand, there is perfect agreement among experts with regard to the disintegrating action of chloride of magnesium and sulphates soluble in water, as, for instance, sulphate of potassium, sulphate of sodium and ferrous sulphate. Chloride of potassium and ammonium chloride are often considered harmless, but the report states that in face of the experience of the alkali industry the correctness of this view is open to doubt. All potassium salts are destructors of concrete, while sodium chloride does not possess destructive properties. This fact has already formed the subject of many controversies, it being pointed out that sea water has in many cases had a rather destructive effect, but the research committee holds that such effects were principally due to the presence of chloride of magnesium and sulphate of magnesium.

A series of further experiments proved that even water of a reltaively high degree of purity containing but a minimum percentage of mineral matter may destroy concrete, inasmuch as it dissolves and washes away the hydrate of lime which is separated in the hardening of concrete. The process of destruction will even be precipitated if the water contains carbonic acid, for the latter will soon cause the formation of bi-carbonate of lime.

On the whole, the experiments proved that ordinary portland cement is not suitable for concrete subject to the action of acids or salts and it is suggested that in such cases ferrous portland cement or any other containing a minimum of lime should be used. As regards the use of protective coatings, asphalt varnish proved very serviceable in protecting concrete against the disintegrating effects of water containing a high percentage of carbonic acid, while the effect of other acids of low concentration were successfully countered by a coating which proved immune against the action of the respective acid. Whenever acids of a highly concentrated form were used, including benzine, protective coatings were practically useless and covers of lead, ebonite, or acid-proof ceramic slabs with their joints filled up by acid-proof cement, became necessary. Attention was also drawn to the electrolytic effects often caused by the connection between concrete and metallic coverings, an insulating coating between the two materials, preferably tar, being suggested as a remedy.

Strauss Bridge Patent Case Settled By Chicago

The suit of the Strauss Basculo Bridge Co. against the city of Chicago for infringement of the Strauss patent No. 995813, issued June 20, 1911, by the U. S. Patent Office, was finally settled Nov. 19, when the city paid the company the sum of $348,500.

The Strauss patent in question relates to a method of supporting the bascule leaves which eliminates the interference of the inside trunnion supports with the movements of the tail-end of the leaf or the counterweight and thus does away with the costly means otherwise necessary to meet this difficulty. The testimony showed that this is a vital fundamental of design and not an incident or minor detail; that it embraced a new type of bascule truss which permits a cross girder to be passed through it without limiting its full opening and on which the trunnions are mounted, allowing necessary room for the large volume required for a low cost counterweight, such, for example, as concrete. The large volume low cost counterweight was one of the chief underlying aims and objects of the Strauss construction and was first applied in service in the Strauss through-trunnion supporting girder bascule bridge of the W. & L. E. R. R. built at Cleveland in 1904. The truss construction with the through-trunnion supporting girder and large bulk counterweight was employed by the city of Chicago for the first time in the Washington St. Bridge, completed about 1913 (the bridge named in the infringement suit).

The suit was filed March 11, 1913, and all proceedings have been in the Federal Courts. The testimony was taken before a Master in Chancery, who rendered a decision holding that none of 46 permits claimed by the defendants as anticipations of the Strauss bridge, nor the Tiber River Bridge, anticipated the Strauss invention, that the Strauss patent was valid and that the city had infringed it.

The city's attorney then filed objections to the Master's report, and the matter was then taken up before Judge Carpenter, who affirmed the Master's report, holding the Strauss patent valid and infringed by the city. The city then appealed the case to the U. S. Circuit Court of Appeals, which unanimously affirmed Judge Carpenter's decision. The city was now at the end of its efforts to have the patent declared invalid, and the only thing left was the accounting before the Master to ascertain the amount due the Strauss Bascule Bridge Company.

In the negotiations for settlement a tentative figure of $527,095 was arrived at. This is 7¼ per cent of the cost of the superstructure of 13 bridges, 10 of which were completed or under construction, and 3 more designed.

The finance committee of the City Council then took up the matter and appointed a sub-committee to investigate the entire situation. This sub-committee in turn selected its own attorneys and engineers to advise it, appointing Robert H. Parkinson of the firm of Parkinson & Lane, patent lawyers, to make an independent investigation and report, and appointing J. H. Prior, an engineer and member of the Western Society to co-operate with Mr. Parkinson and a committee of the Western Society of Engineers in the investigation. Nothing, however, was developed to warrant reopening the case.

The finance committee then resumed settlement negotiations. The Strauss Company finally accepted a settlement of $348,500 on the basis of 10 bridges instead of the original 13; that is, the 10 bridges then built. The other three bridges which had progressed no further than the design, were excluded from the settlement, and included in the injunctive order to be granted by the court. This settlement figure, which represents 6.98 per cent of the cost of the superstructure (for royalty alone exclusive of engineering services of the company, i. e., the preparation of designs, plans and specifications), was presented to the Master and incorporated in the Master's report. This settlement agreement was reached in July, 1920.

Should the Builder Be Licensed?*

By O. W. ROSENTHAL,
President O. W. Rosenthal-Cornell Co., Chicago

That the protection of the public against unscrupulous, dishonest, inefficient, and careless persons must necessarily be a primary consideration, is unquestioned.

The efforts of the state to give to the public this protection have brought about a supervision of private industry that to many seems extreme. It, however, is generally admitted that in most instances some supervision or control is necessary.

The necessity for state control in the practice of medicine, pharmacy, dentistry, law, architecture and engineering of banks and the sale of securties, and of the many other branches over which the state has extended its supervision is unquestioned by any who have given the matter thought.

There have been no acts passed by our legislature that would have been productive of greater good than those for the control of architecture and engineering, had they gone one step farther and enacted some legislation for the control of the builder. As the matter now stands, the protection is incomplete and largely fails of its purpose.

The registration of architects and engineers leaves no question that the legislature is alive to the hazardous nature of a building operation and recognizes its public character.

The mechanics' lien law, the workmen's compensation act, and the many precautionary measures for the protection of the workingman and the public which are left for enforcement to the state factory inspector are further evidence that our law makers realize the perilous and unusual character of a building operation.

The various building codes and sanitary measures give further assurance that every effort is being made to safeguard the public health and welfare, but the one great fundamental protection to which the public, the workingman, the future occupant of the building, the investor, and the seller of materials is entitled, is control of those who practice the art of building by a license board created by the state. A license board with power so broad that it could demand of anyone desiring to engage in the practice of building that he give satisfactory evidence of his ability to practice the art in the best and most efficient manner. A board with the power of revocation of licenses.

The registration of architects and engineers assures the public that the codes will be adhered to so far as the design is concerned, and that the architecture and engineering will be sane and safe, but the execution of the design is in the hands of an unregistered builder who has never been required to give evidence of his ability to carry on successfully so dangerous and important and so public an undertaking.

The enforcement of the various codes covering a building operation must of necessity be perfunctory and left largely to the honor of the builder when building is at its height. Where an infraction of the code is discovered, the wreck is stopped temporarily or the correction is ordered. The penalties are absolutely insufficient. The architect and engineer do not necessarily supervise the execution of the design. The responsibility resting upon the builder is one that should be placed only upon the shoulders of one who has given evidence of the necessary ability, and who is under state control.

There is expressed everywhere throughout our statutes the feeling that control of building is regarded as of extreme importance. Yet the efforts to control as evidenced by the various building and sanitary codes, the mechanics' lien law, the workmen's compensation act, the architects' and engineers' registration acts, and the various safety measures fail of complete potency so long as the builder (the one who carries on the actual construction of the building) is not directly answerable to the state.

The economic waste and the loss of life due to incompetence, inefficiency, and lack of moral responsibility would be surprising could the facts be known. The factors of safety employed by architects and engineers, based of course largely upon experience, is based not entirely upon the uncertainty of materials and the natural carelessness of the craftsman, but also upon the inefficiency and the lack of even reasonable, to say nothing of thorough supervision or knowledge on the part of the builder. What seems to be an excessive cost of liability insurance and [illegible] also is due largely to these conditions.

Public welfare demands that [illegible] and collusion practiced in connection with building operations be stopped, and this can be done only by state [illegible].

The question of the [illegible] of the mechanics' lien law as it is now drawn, and which is intended as protection against the unscrupulous or careless builder will not be important when the interest of the seller of materials, the investor, and the public are protected by the state control of the builder.

There are many engaged in the practice of building who are wholly unequipped by experience, temperament, or a sense of moral responsibility to engage in so dangerous and difficult a profession. To permit others to engage in the practice without making an effort to ascertain their fitness would indeed be a mistake.

We are at the present time facing a most unusual situation as regards a lack of building in the face of a most unprecedented need of buildings of every description. It can reasonably be expected that this condition will soon be corrected, and with the revival of building operations the public should be protected from the dishonest, incompetent, inefficient and irresponsible builder.

It is almost unbelievable that any one without previous experience can engage in so dangerous a profession and be answerable to no one. Under our present laws one can be a doctor, a lawyer, a butcher, or a baker today, and a builder tomorrow, for no reason other than he so wills it, with no previous experience, without control, and without regard to the interests of the public. This is not a healthy condition, and should not be permitted.

The honest builders of this state should be in favor of any legislation that will eliminate the unscrupulous builder who evades the building codes, and in many other ways conspires to defraud the public with no regard for the dangers of such a practice.

Consequent to the establishment of such a board will be a great moral awakening in the building profession. A better understanding of the duties and obligations of those engaged in the practice will result. The tendency of many builders to put up the building at a profit, regardless, will be greatly lessened. It will cause to be established a code of ethics and will compel obedience. It will bring about a recognition of the real standards of the profession, and the public, the workingman, the architect, the engineer, and the seller of materials will be reassured when it is known that the art of building is in the hands of competent builders who are under the control of a state board which has the power to enforce its rulings.

The establishment of this board is a public necessity.

---

*From the American Contractor

Teredo Damage in San Francisco Bay $25,000,000 Within Two Years

A serious emergency has been caused in San Francisco Bay by the enormous increase in damage from marine borers to water-front structures within the past two years. This recent damage is most serious in the upper Bay, from Mare Island Navy Yard up Carquinez Straits and the lower Sacramento River. A survey of the damage and an investigation looking to the best means of combating the marine borers have been undertaken by the Forest Products Laboratory of the U. S. Forest Service, in co-operation with the San Francisco Bay Marine Piling Committee of the American Wood Preservers' Association, under the chairmanship of Mr. F. D. Mattos, Superintendent of Creosoting Plants for the Southern Pacific Co. This committee is composed of the engineering representatives of the State Board of Harbor Commissioners, the principal railroads, oil companies and shipping interests having waterfront structures in the Bay, and who are financing the investigation, together with representatives of the Army, Navy, U. S. Engineering Corps, Immigration Commission and Lighthouse Board, and the University of California, the latter through Professor C. A. Kofoid, marine biologist, who is studying the biological aspects of the problem. The Forest Products Laboratory is represented by Mr. Geo. M. Hunt, Chief of the Section of Wood Preservation, and Mr. T. G. Townsend, Engineer in Forest Products, who are conducting the survey. The executive officer of the committee, to whom communications may be addressed, is Mr. C. L. Hill, Chief of the Office of Forest Products, U. S. Forest Service, Ferry Bldg., San Francisco, Calif. Its fiscal agent is Mr. E. M. Baker, who is also [illegible] of the committee.

Marine borer attack upon waterfront [illegible] for a long time in San Francisco Bay [illegible] called [illegible] Mare Island up the Sacramento River, [illegible] until within the past three years, been free from marine borers on account of the large volume of fresh water discharged into the bay by the river. A shortage of fresh water flow, caused by several past dry years and the increasing diversion of irrigation water from this river, apparently coincided with a new invasion of the [illegible] which is the species of shipworm that has caused great damage to harbor structures all over the world for centuries, but which has not previously been known in San Francisco Bay. This teredo has come in great numbers in [illegible] parts of the bay. There, by reason of the past [illegible] there were large quantities of untreated wooden [illegible] the attacks of the teredo have been so rapid and [illegible] that structures valued at many millions of dollars are already practically destroyed. Docks have been failing, and frequently dropping off into the bay, with accompanying menace to other structures during the entire year past. The damage, which has been estimated by the committee at $25,000,000 up to the present time, bids fair to greatly exceed that sum in the near future.

This study will be the first unit of a nation wide investigation under the auspices of the United States Forest Service and co-operating associations of wood preservers, lumbermen, railroads and many other industries having interests at stake, which will cover the entire coastal waters of the continental United States. Its ultimate object will be to find the best possible means of combatting these attacks and to increase the effectiveness of the means now employed.

As complete a report as possible is to be prepared by the San Francisco Bay Marine Piling Committee on the findings to date for presentation before the 17th Annual Meeting of the American Wood-Preservers' Association, which will be held in the St. Francis Hotel at San Francisco, Calif., on Jan. 25, 26 and 27, 1921. This report will contain several maps and diagrams, a number of plates made from a selection out of a large number of photographs and photomicrographs taken during the investigation and will be published in form for distribution.

Concrete Piles on 2-½ft. Centers in Building Foundation

Concrete piles spaced 2½ ft. centers were used in constructing an addition to the Hotel Bond at Hartford, Conn. The original 6-story structure rests on spread footings, but the addition is to be 12 stories in height and the archiects and engineers considered that for this addition concrete piles would be more economical. To save expense in excavation and the concrete caps on piles it was desirable to drive the piles on as close centers as possible and it was decided to use 2-ft. 6-in. centers, which meant that 16-in. piles would only be separated by 14 in. measured from edge to edge of [illegible] The soil consisted of almost incompressible clay and [illegible] recognized, presented the worst possible conditions for [illegible] driving. The contract for the piling work was let by the George A. Fuller Co., the general contractors, to the MacArthur Concrete Pile & Foundation Co., New York City, who [illegible] concrete pedestal piles by their standard method. [illegible] the incompressible nature of the soil the surface of the ground raised some 2 ft. during driving operations, but the tops of the piles remained at their original level, [illegible] that they were unaffected by the adjacent soil displacement. For demonstration of this fact a number of clusters of piles were uncovered. Each pile was found to be perfect and uniform in section.

Pile Cluster Uncovered for Inspection.

Large Manufacturing Center to Be Developed at Jacksonville, Tenn. The Nashville Industrial Corporation, composed of business men of Nashville, Tenn., have purchased from the U. S. Government the Old Hickory Powder Plant at Jacksonville, Tenn., located 12 miles east of Nashville, on the navigable Cumberland River. The purpose of the Nashville people is to industrially develop this immense war undertaking into a large manufacturing center, having available immense housing and manufacturing buildings and facilities. The village had a population of 35,000 when the plant was closed in 1918, and is now completely equipped with all necessary public utilities, schools, banks, club houses, etc., and offers many attractive inducements to new industries or those desiring a change in their location. This government manufacturing undertaking cost over $87,000,000. It occupies 5,100 acres of land, has a water filtration system capable of supplying a city the size of Boston, one of the largest steam power plants in the world, a double track railroad connecting with trunk lines, 35 miles of industrial track connecting manufacturing buildings, an immense refrigeration system, complete water works, sewerage system, fire departments, concrete and macadam roads. A great quantity of surplus material in the manufacturing area will be dismantled and sold.

Personals

John Klorer, assistant state engineer of Louisiana, has resigned to become city engineer of New Orleans, La.

B. B. Steiber, 467 Wood Ave., Bridgeport, Conn., and R. G. Milliken of Stratford, Conn., have organized the Eagle Construction Co. of Bridgeport, and will engage in contracting.

Samuel W. Dudley, chief engineer of the Westinghouse Air Brake Co., has been chosen Professor of Mechanical Engineering, on the Strathcona Foundation by the Yale Corporation, it was announced Dec. 14. Professor C. J. Tilden of the Department of Engineering Mechanics, the announcement also says, has accepted the directorship of a national movement which has for its immediate object a broad educational program along highway engineering and highway transportation lines, the details of which are yet to be announced.

Obituaries

Michael Stanton, a contractor of Leavenworth, Kan., died Dec. [illegible], aged 81.

Col. Amos Rood, founder of the Chicago Sand & Gravel Co., Chicago, died Dec. 14 at Grand Rapids, Mich. He was 82 years old.

Manus J. Fish, formerly superintendent of public buildings of Boston, Mass., died Dec. 14 at his home in Dorchester, Mass. He was 61 years old.

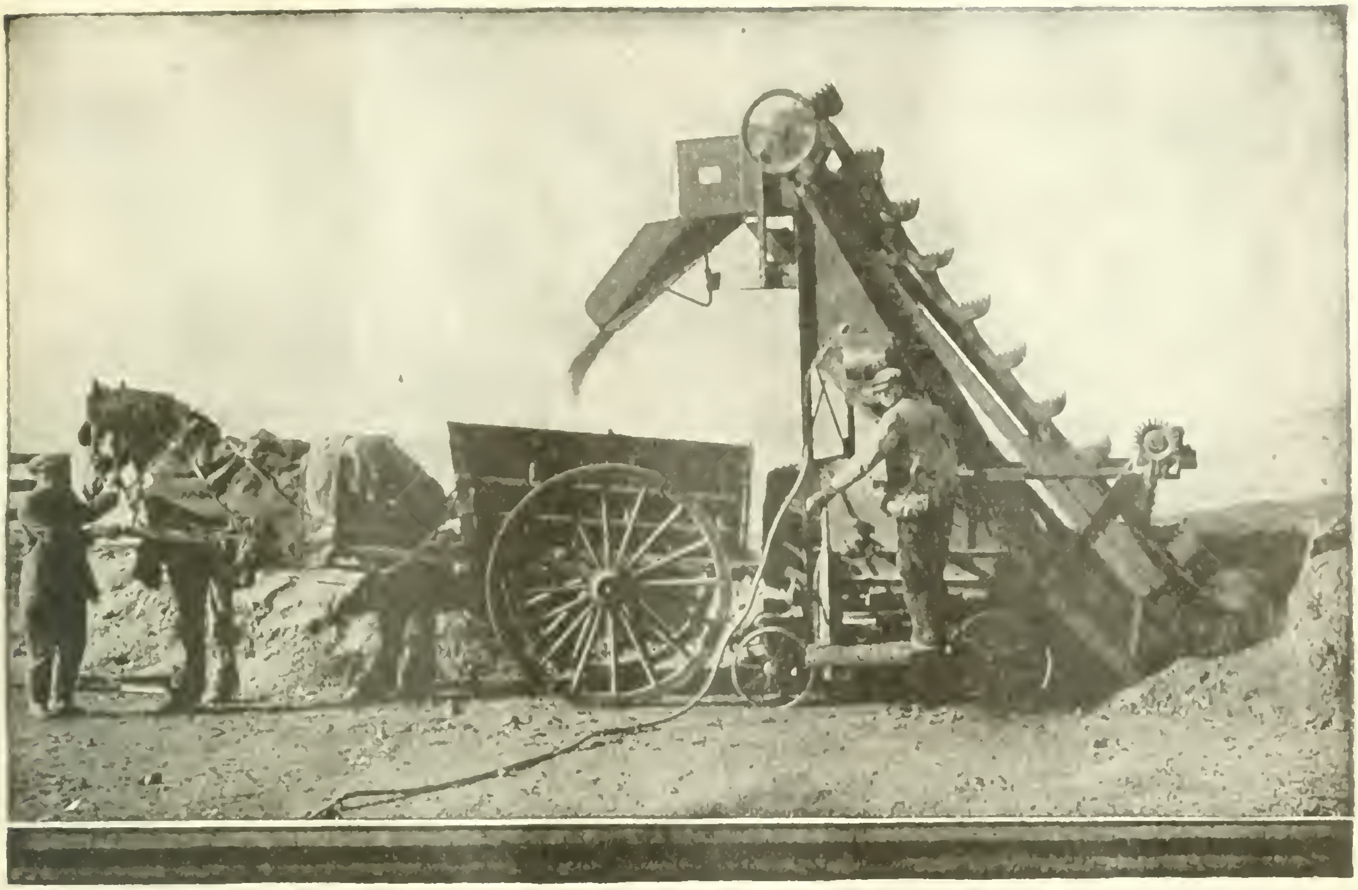
H. B. Kelsey, district manager at Pittsburgh for the Foundation Company, died in a New York hospital after an illness of three weeks. He was 36 years old and had been with that company for more than 15 years. He was in charge of the Pittsburgh district for the last two years.

Industrial Notes

The Mundie Mfg. Co., Peru, Ill., announces that it has adopted the Climax model "T," 5½ in. by 7 in. motor as standard power equipment for its No. 8 10 in. by. 10 in. "Zin-Ho" compressor. This model "T," 5½ in. by 7 in. engine is the very latest design of heavy duty engine developed by Climax Engineering Co. of Clinton, Ia.

The Republic Iron Works, Tecumseh, Mich., has been brought into the control of W. F. MacGlashan, president of the Beaver Board Companies, and J. B. Carson, president of the Acme Steel and Malleable Iron Works, and other metal working institutions. An improved line of concrete mixers will be brought out in 1921. The plant will concentrate on the production of two sizes, one of 10 cu. ft. capacity and one of 6 cu. ft.

Chas. T. Topping, formerly of the Chas. T. Topping Machinery Co., Pittsburgh, dealers in contractors' equipment, who has been associated with the Lakewood Engineering Co., Cleveland and New York, the past two years, resigned recently to re-engage in the construction machinery business for himself. He has established his organization in the House Bldg., Pittsburgh, and will act as district sales representative for the Austin Machinery Corporation, Chicago, manufacturers of concrete mixing, excavating, road building and material handling machinery and equipment.



Reduce Expenses in Handling Materials

A LINK-BELT Portable Loader will enable two men to do the work of from five to ten in loading loose materials of all kinds, such as sand, stone, gravel, coke, coal, clinkers, etc., from ground storage into trucks and wagons.

Such materials can be loaded at the rate of a ton per minute. A Link-Belt Portable Loader enables each team and truck to make many more trips per day. It will relieve yard conjestion. It provides the lowest possible loading cost per ton. Enables you to cut costs by reducing labor.

Made in various types and sizes, hand or power propelled, swiveling and non-swiveling types; suitable buckets for loading any given kind of material,

Our 80 page book No. 450 giving complete details mailed on request.

Link-Belt
"Industrial Type"
Collapsible,
Self-Propelled
Loader.

This machine is designed to handle all materials, and is ruggedly built to withstand the hardest service.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

New York . . . . . 299 Broadway
Boston 9 . . . . 49 Federal St
Pittsburgh . . . . 1501 Park Bldg
St. Louis . . . Central Nat'l Bank Bldg
Buffalo . . . 847 Ellicott Square
Wilkes Barre . . . 2d Nat'l Bank Bldg
Huntington, W. Va. . . Robson Prichard Bldg
Cleveland . . . . . 429 Kirby Bldg
Detroit . . . 4210 Woodward Ave
Kansas City, Mo. . . 306 Elmhurst Bldg
Birmingham, Ala. . . S. L. Morrow, 720 Brown Marx Bldg
Seattle . . . 820 First Ave., S.
Portland, Ore. . . First and Stark Sts
San Francisco . . . 168 Second St
Los Angeles . . 163 N. Los Angeles St.
Toronto Can. . . Canadian Link Belt Co., Ltd
Montreal, Can. . . Canadian Link Belt Co., Ltd.
Denver . . Lindrooth, Shubart & Co., Boston Bldg
Louisville, Ky. . . Frederick Wehle, Starks Bldg.
New Orleans . . C. O. Hinz, 504 Carondelet Bldg
New Orleans . . Whitney Supply Co., Ltd., 418 S. Peters st

148-A

LINK-BELT
PORTABLE LOADERS

JUST A FEW of the many companies who have tried one ERIE, and then bought more.

NEW ENGLAND

[illegible]	7 Eries
[illegible]	[illegible]
[illegible]	4 Eries
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	10 Eries
[illegible]	[illegible]

MIDDLE ATLANTIC

[illegible]	[illegible]
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	4 Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	4 Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible] Pittsburgh, Pa.	[illegible] Eries
[illegible] Pittsburgh, Pa.	[illegible] Eries
Wm. Steele & Sons, Philadelphia, Pa.	[illegible] Eries

SOUTH

[illegible] Va.	[illegible] Eries
[illegible]den-Ozark [illegible] Project, Marion, Ark.	10 Eries
[illegible] Railroad, Louisville, Ky.	5 Eries
Robert G. [illegible] & Co., Norfolk, Va.	4 Eries
H. C. [illegible], Baltimore, Md.	4 Eries
[illegible] Construction Co., Knoxville, Tenn.	5 Eries
[illegible] & Co., [illegible], W. Va.	4 Eries
[illegible] Construction Co., [illegible]ville, K[illegible]	3 Eries
[illegible] Co., [illegible], Fla.	6 Eries
[illegible]	3 Eries

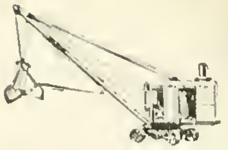
WEST

[illegible] R. R.	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	6 Eries
[illegible]	[illegible] Eries
[illegible] Mo.	6 Eries
[illegible]	[illegible] Eries
[illegible]	4 Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries

[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries
[illegible]	[illegible] Eries

[illegible]qualled Steam-Shovel

Before you spend a single dollar—



Convertible to Locomotive Crane

Let us submit DEFINITE PROOF that you will prefer the ERIE

We are practically *sure* that you will prefer the ERIE after you try it—and here is why we are sure:

Although there are more than 1400 ERIE Shovels in service, we know of only three concerns who have bought some other make of $\frac{3}{4}$-yard or $\frac{1}{2}$-yard shovel after buying their first ERIE. And one of these three concerns was glad to come back to the ERIE again, by buying another ERIE a year later.

That leaves a total of *just two* steam-shovel owners who can be counted as strayed from the ERIE Shovel fold.

☞ In contrast with the two we have lost, just look at some of the companies who keep coming back to us, buying more and more and more ERIES.

Nearly all these are experienced steam-shovel users, who have owned several other makes of steam-shovels before buying their first ERIE. They know enough about steam-shovels to truly appreciate what the ERIE is.

THEY HAVE FOUND the ERIE so speedy that it does work which would otherwise require a larger and far more costly machine. The ERIE saves them thousands of dollars in plant investment.

THEY HAVE FOUND that the ERIE can be depended on to work steadily with few renewals, and practically no attention for repairs. The ERIE is built far stronger than the usual standard of construction. More strength at every point of wear and strain.

THEY HAVE FOUND that the ERIE is efficient on many different kinds of work; cellar excavation, street grading, loading rock in quarry service. Trench excavation. Coal stripping and loading. The ERIE with its crane boom handles clam-shell, orange-peel or drag-line bucket with splendid results.

We would like to send you a Bulletin which shows the different kinds of work that the ERIE can do, and also gives yardage and cost figures. Write for a copy of Bulletin E. Address:

BALL ENGINE CO., Erie, Pa., U. S. A.

Builders of ERIE Steam-Shovels and Locomotive Cranes, Railway Ditchers

Branch Offices: New York, Boston, Chicago
Representatives throughout U. S. A.

ERIE Revolving Shovels

BALL Engine Co. Erie, Pa.

WATER

Over Four Million Gallons Per Day

Supplied by one

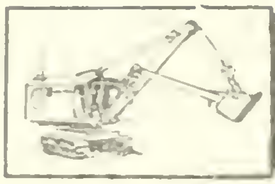
Layne Vertical Turbine Pump Installed in a Layne Rotary Well

FIVE units like this are furnishing the entire water supply for a large city, and saving the city fifty per cent of the amount originally spent for operating the old fashioned plant.

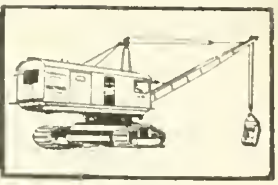
Our specialty is installing complete water supply plants or making over "sick" plants. If in need of a new water supply, an addition to your present supply, or if you have a plant which is costing too much to operate, let our engineers go over your proposition and ascertain what you need to save real money. Their services are yours for the asking, with no obligations on your part.

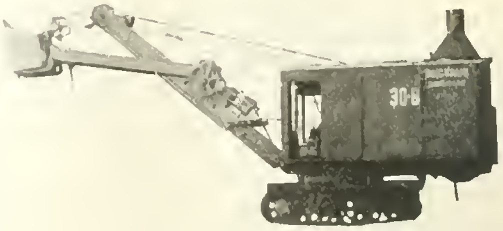
WRITE FOR OUR LATEST BULLETIN.

LAYNE & BOWLER COMPANY
"WORLD'S LARGEST WATER DEVELOPERS"
MEMPHIS - - - TENNESSEE



BUCYRUS





In an Undermanned World

The BUCYRUS 30-B Universal

Shovel--Dragline--Crane

Is the last word in practical efficiency and economy. Now when winter is on and working forces are reduced, is the time to look over your equipment and see where you can meet the severe competition of 1921. The 30-B Universal shovel is a combination of steam shovel, dragline excavator, sewer digger or crane (with or without clam shell equipment).

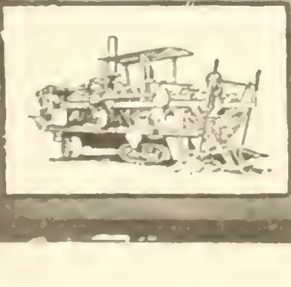
First in variety of uses
First in high earning power
First in service to its owner

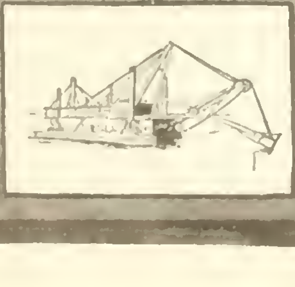
Send for Bulletins C-301-E.

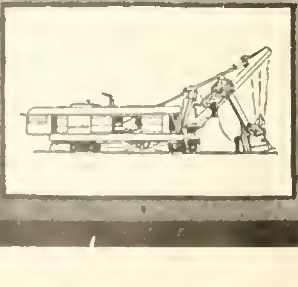
BUCRYUS COMPANY

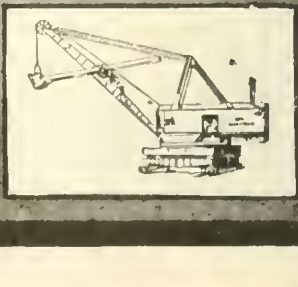
South Milwaukee, Wis.

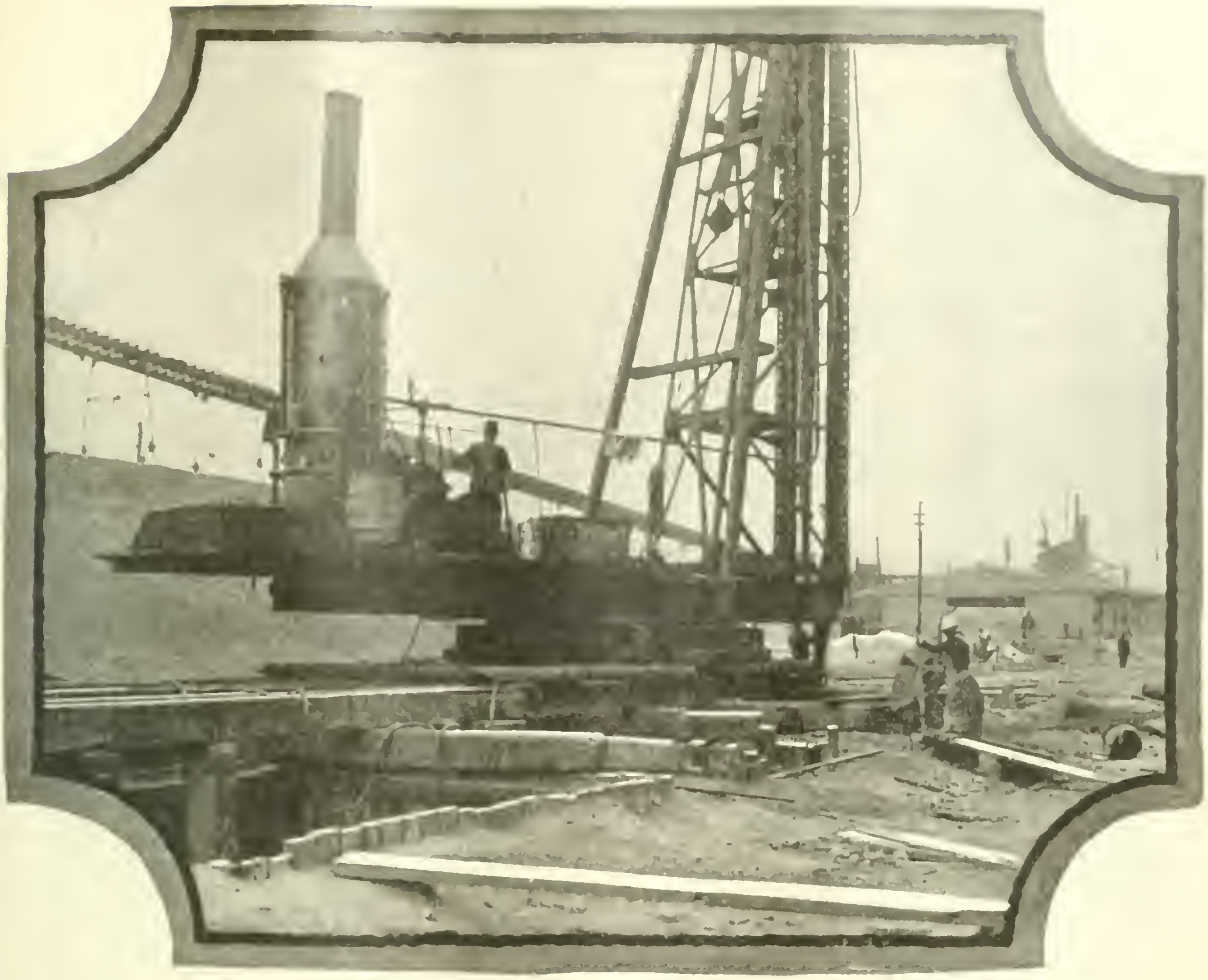
New York, Portland, Ore., Chicago, San Francisco,
Denver, Birmingham, Salt Lake City,
Minneapolis, Cleveland











'ROUND swings the driver—while one spirally reinforced steel shell, driven and left in the ground, is being filled with concrete another is being driven—no delays—no holdups—no danger. Because the protection rendered to the concrete pile column by the steel shell makes **certain** that no unfavorable underground conditions can weaken or distort the pile. The Raymond ways is the safe way—also the cheapest in the end.

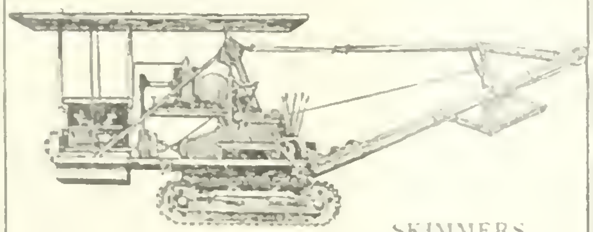
RAYMOND Concrete Piles

Raymond Concrete Pile Company

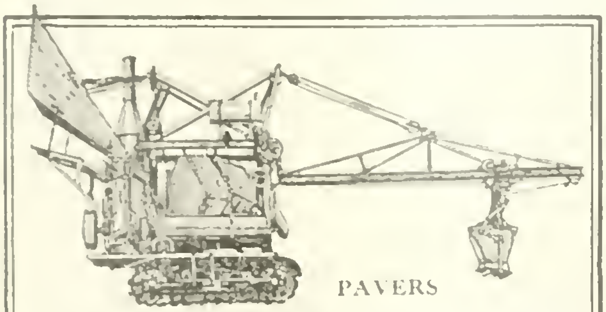
NEW YORK: 140 Cedar St. CHICAGO: 111 W. Monroe St.

Montreal, Canada: Raymond Concrete Pile Company, Ltd.

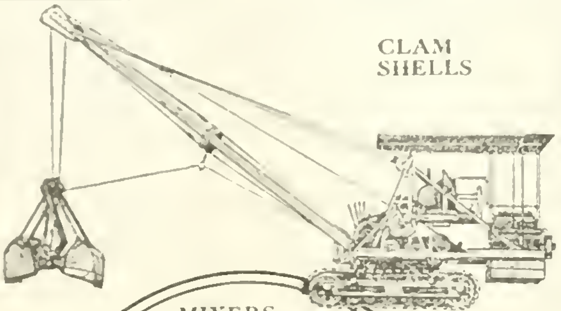
A Form for Every Pile A Pile for Every Purpose



SKIMMERS

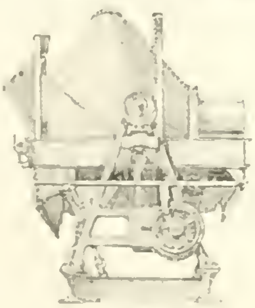


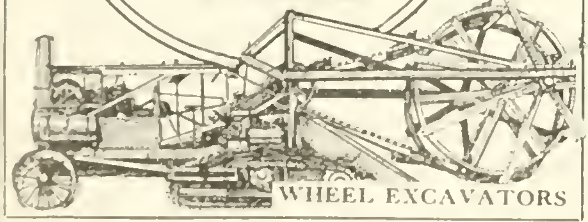
PAVERS



CLAM SHELLS

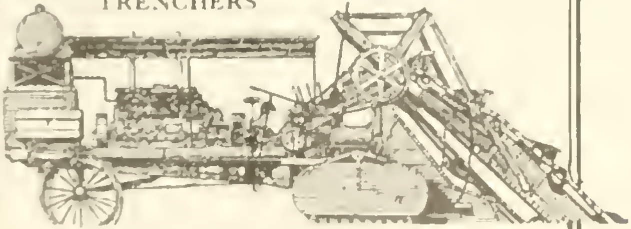
MIXERS





WHEEL EXCAVATORS

TRENCHERS



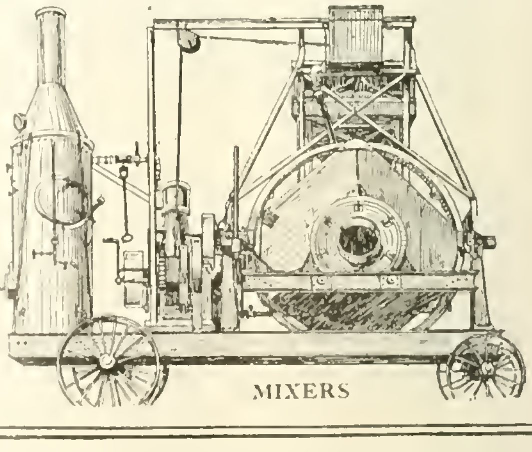
The Austin

Specialized Machines

Most people who succeed are specialists—the fellows who stick to one thing and do it well; you know that.

We knew it too, 40 years ago; so we started out to become specialists in the manufacture of coal handling, earth moving and concrete mixing machinery; and still we're specializing.

No matter what kind of an Austin machine you buy today you may be certain of this: its design and construc-



MIXERS

Line—

for General Jobs

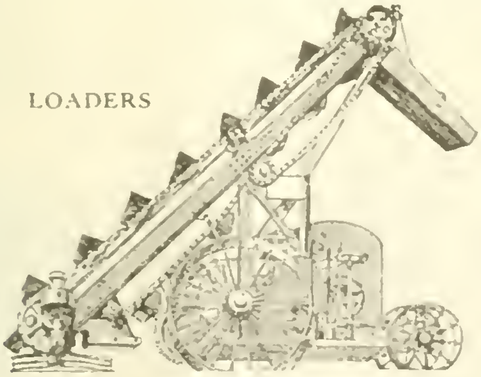
tion are what we have found, in 40 years of "on the job" experience, to be best suited to meet actual everyday working conditions.

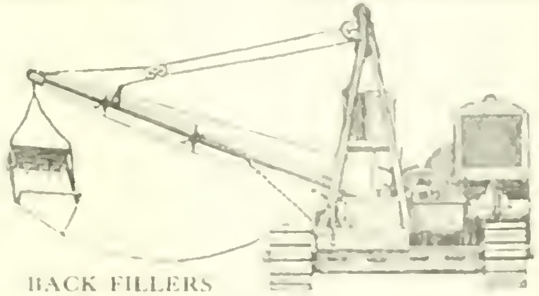
That experience cost us a lot; we protect what it taught us with the Austin trade-mark registered in 39 countries.

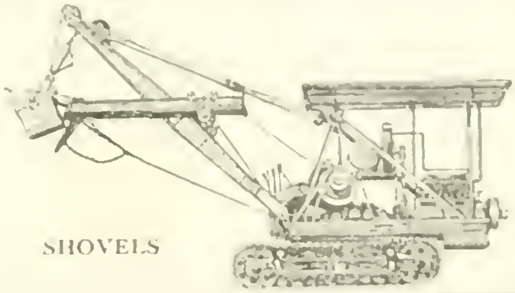
We have interesting informative booklets on every machine in the Austin line—write for Booklet No GL9

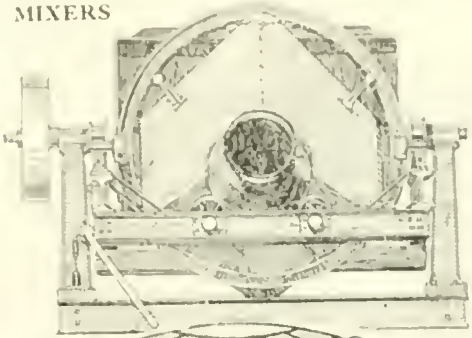
Austin Machinery Corporation
F. C. Austin Consolidation

Chicago Office: Railway Exchange Building
Atlanta Office: 10 West Harris Street
New York Office: 30 Church Street


LOADERS

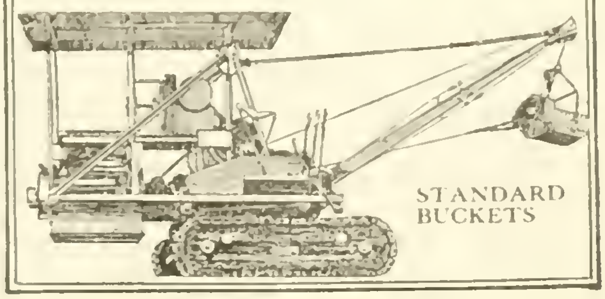

BACK FILLERS


SHOVELS


MIXERS

AUSTIN MACHINERY
"MOVES THE EARTH—
MIXES THE CONCRETE"
TRADE MARK

GASOLINE LOCOMOTIVES


STANDARD BUCKETS

Melting snows of Mt. Rainier highest peak in continental United States are converted into light, heat and power through the agency of wire-wound wood pipe.

Illustrating how the sections of wire wound wood pipe are joined together with wood couplings, making a perfectly tight joint without the use of packing.

Finished pipe through which flows the water that is used to light the mountain.

Redwood —— Douglas Fir

WOOD PIPE

CONTINUOUS STAVE - WIRE WOUND - BORED

Lighting a Mountain

How Wire Wound Wood Pipe Is Used to Furnish Light, Heat and Power on Mt. Rainier

Ease of transportation and unequalled adaptability of Wood Pipe are illustrated in the installation of a water power development high up on the sides of Mt. Rainier—tallest peak in continental United States. At Longmire Springs, where thousands of sight-seers every year view the Mountain in all its grandeur, new development will convert the eternal snows into electric light, heat and power.

Wire Wound Wood Pipe for this installation was transported with ease up the sides of Mt. Rainier, and was put in place with facility. Covered with snow much of the year, subject to severe freezing weather, Wood Pipe was selected for the qualities that go to make permanence and efficiency.

Wood Pipe is providing the means for unlocking America's great water-power wealth. Of the estimated horsepower—from 50,000,000 to 200,000,000—available in this country only the smallest fraction has been developed. Wherever water runs down hill you find water-power possibilities awaiting development. Every state in the Union, with two exceptions, offer marked possibilities for water power development.

Wood Pipe is unlimited in its range. Wire wound Wood Pipe is furnished in sizes from 2 inches up to 32 inches inside diameter. Continuous stave pipe installations have been made up to 14 feet inside diameter, and the limit has not been reached. Wire wound Wood Pipe comes complete with couplings. Continuous stave is shipped "knocked down" and is assembled on the ground into a completed pipe line.

Wood Pipe economically solves any water conveyance problem. Put yours up to our engineers.

WESTERN WOOD PIPE PUBLICITY BUREAU
WHITE BUILDING, SEATTLE, U. S. A.

Address All Inquiries for Details and Prices to the Following:

Continental Pipe Manufacturing Company, Seattle
American Wood Pipe Company, Tacoma
Pacific Tank and Pipe Company, San Francisco
Redwood Manufacturers Company, San Francisco

Redwood —— Douglas Fir

WOOD PIPE

CONTINUOUS STAVE-WIRE WOUND-BORED.

PIERCE-ARROW
2-ton, 3½-ton, 5-ton
Dual Valve Trucks
Mean Added Power

Increased valve area—
larger intake and quicker exhaust—
and complete gasoline consumption
assure full power delivered by
each explosion of gas.

THE result not only is power equal to any demand, but many signal economies: time-saving, easy handling, minimum strain, labor saving and surprisingly small gasoline consumption.

All of these savings reduce cost of operation and increase profits to the owner.

PIERCE-ARROW has been noted always for freedom from breakdowns and minimum repair expense. The accessibility of every part materially cuts down labor cost of necessary repairs. Keeping trucks running is an essential of successful operation and a major Pierce-Arrow objective.

Pierce Arrow

48 of the FIRST FIFTY trucks still running after 9 years' service.

Delivers more work in a given time.

Loses less time on the job and off the job.

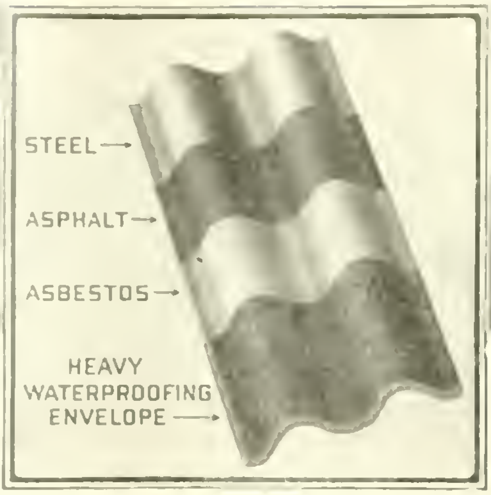
Costs less to operate and less to maintain.

Lasts longer, depreciates less, commands a higher resale price.

THE PIERCE-ARROW MOTOR CAR COMPANY, BUFFALO, N. Y.

ROBERTSON

METAL FOR ROOFS



The opposite illustration shows the three protective coatings which provide an impregnable shield for the specially annealed steel which forms the core. An actual sample will be sent to you upon request.

Robertson Process Metal

Light, Strong and Permanent

A square of Robertson Process Metal weighs, on the average, only 200 pounds. Its covering area per ton is greater than that of any other permanent building material.

This "three-time" protected metal can be erected as quickly and economically as corrugated iron. Its lightness, strength and permanency reduce building costs. The light-weight feature insures minimum freight charges. It is especially suitable for industrial building construction where combined smoke, fumes and moisture soon rust unprotected metal.

Robertson Process Metal is the ideal material for roofing siding, trim, skylights and ventilators. It saves first costs and maintenance costs. It is immune to the corrosive action of weather, strong acid and alkaline fumes. Three impervious coatings (a) Asphalt (b) Asbestos (c) Waterproofing provide this immunity.

A sample like that illustrated above will be gladly sent to you upon request. Interesting literature explaining further advantages of Robertson Process Metal will also be mailed. *Write for them today.*

H. H. ROBERTSON COMPANY, Pittsburgh, Pa.
Formerly Asbestos Protected Metal Co. (A. P. M.)
Factories Ambridge, Pa.; Waltham, Mass.; Akron, N. Y.; Sarnia, Ont.
Branch Offices In all principal cities in the United States.
For Canada H. H. Robertson Co., Limited, Sarnia, Toronto, Montreal, Vancouver, Winnipeg, St. John, N. B.; Halifax, N. S.
Export Division 31 Union Square, West, New York City; London, E. C., England Elw LeBas & Co., Dock House, Billiter St.

PROCESS
SIDING AND TRIM
TRADE MARK REG. U. S. PAT. OFF.

The Pacific Lumber Company's Mills, Yards and Employees' Homes

IF YOU SHOULD GO TO CALIFORNIA

WE WOULD like you to go up to Humboldt County—into the heart of the Redwood region. You could hardly fail to be inspired by the rugged grandeur of these magnificent Redwood Forests; and you would be truly interested, we believe, to get a glimpse of the great industry by which this beautiful and romantic timber is turned into lumber for so many practical purposes.

Two Kinds of Redwood

You would soon learn that the Redwood used for commercial lumber is not the Sequoia Gigantea—the famous "Big Trees" in the National Parks of the Sierra Nevadas—but is a different species, the Sequoia Sempervirens (Ever-living), which grows in ample commercial quantities along the northern coast of California.

Scotia The Home of Redwood

In the heart of Humboldt County you would find the town of Scotia, where The Pacific Lumber Company's big mills are located, and where the population of 3500 is made up almost exclusively of Company employees and their families. To these mills, producing half a million feet of lumber every eight hours, the giant Redwood logs are transported on the Company's own logging trains, after the trees have been felled, cross-cut and peeled by the Company's woodsmen. The mills and yards are equipped with a complete system of electrically operated overhead monorails and cranes, sorting tables, and other mechanical devices, so that every log and every piece of lumber is handled in the most efficient and economical way.

Efficient Production Aided by Wholesome Living Conditions

In its man power, also, you would find Scotia well equipped. By means of its model logging camps with toilets and showers, clean sleeping quarters, neat kitchens, serving excellent food in comfortable dining-rooms, by its pleasant, cottage-homes, its Men's Club, Community Theatre, and Recreation Center, The Pacific Lumber Company has attracted to its mills the most substantial type of lumber workers. These facilities, both human and mechanical, are of direct advantage to our patrons.

Properties of Redwood

A natural preservative which permeates Redwood accounts alike for the great age of the timber (Redwood trees are the oldest living things) and for the lumber's remarkable resistance to decay. A Redwood log buried in the ground for 600 years was found to be still sound and was actually cut into first-class lumber.

Containing, as it does, no pitch or other resinous substance, Redwood is slow to ignite, and its resistance to fire (as demonstrated in the San Francisco conflagration of 1906) adapts it to many commercial purposes.

These properties of rot and fire resistance, minimum warp and shrinkage, lack of odor, close grain and easy working texture, have created a wide demand for Redwood for many industrial uses and

In the Town of Scotia, California — The Home of Redwood

for the manufacture of wood specialties like caskets, incubators, silos, tanks, vats, pipes and flumes, cigar and candy boxes, chests, furniture cores, storage battery separators, fire door cores, and many forms of railroad construction and maintenance.

The same characteristics adapt Redwood for many building purposes, such as siding, moulding, window frames, porch columns, balusters, interior and exterior finish, and shingles.

Conservation

Conservation is intelligent use. We are operating on that principle, not only in our logging, where waste is reduced to the minimum, but in our manufacturing, where, due to the completeness of our facilities and the demand for Redwood for such a wide range of uses, we are able to cut up and refine our lumber so as to utilize every part of the log, both high and low grades—even the sawdust and bark. [illegible] not only for [illegible] but for service and economy [illegible].

Nation-wide Service

As the demand for Redwood has increased The Pacific Lumber Company has extended its distributing facilities, and is today prepared to serve lumber users in any section of the country. Pacific Coast business is handled through the Company's main office at San Francisco and a branch at Los Angeles. East of the Rockies, trade is served by a subsidiary company, The Pacific Lumber Company of Illinois, having general sales offices at Chicago, a branch at Kansas City and also sales offices at New York for the convenience of Atlantic Coast buyers. At Chicago is located a warehouse and quick-shipment depot for the convenience of customers who cannot wait for shipments from the Coast. Our offices are prepared to consult with any lumber user concerning his needs and to advise as to the suitability of Redwood and its economical use.

If you are interested in the adaptability of Redwood for your requirements, we shall be glad to give you full information and advice without obligation on your part.

TPL Co. Reg. U. S. Pat. Off.

The Pacific Lumber Co.

REDWOOD

The largest Manufacturers and Distributors of California Redwood

SAN FRANCISCO: 311 California St.   LOS ANGELES: Central Bank Bldg.

Eastern Sales Organization

THE PACIFIC LUMBER CO. OF ILLINOIS

1104 Lumber Exchange Bldg., Chicago

NEW YORK: 522 Fifth Ave.   KANSAS CITY: Grand Ave. Temple Bldg.

Write Chicago address for any or all of these information sheets

1. General Data Sheet of Redwood: Its [illegible] and Uses.
2. Tanks and Vats for Water, Acid and Alkali Solutions and Oil.
3. Pipe for Water, Chemicals and Sewage Conveying.
4. Caskets, Burial Boxes, Clothing Boxes and Chests.
5. Refrigerators, Ice Cream Cabinets, Fireless Cookers, Brooders, Incubators, Beehives, etc.
6. Farm and Dairy Buildings and Equipment: Silos, Tanks, Pipe, Outbuildings, Irrigation Flumes, Drainage Boxes, Greenhouses, etc.
7. Small Wood Specialties: Cigar Boxes, Toys, Battery Separators, Camera Stock, Pattern Stock, etc.
8. Furniture, Piano Cases, Talking Machines, Filing Cases, Desks, etc.
9. Railroad Construction and Equipment.
10. Industrial Building Materials.
11. Residential Building Materials.

HOLT
PEORIA STOCKTON

Power is the problem of the road builder. From the clearing of the right-of-way thru the grading, leveling and hauling, down to the completion of the road *every operation depends on the power equipment.*

Teams at best are slow, expensive, and limited in their period of operation; motor trucks depend upon speed, but require uniformly good roads; round wheel tractors, regardless of rated power and speed, can be used only on solid surfaces. In contrast, *the "Caterpillar" puts the equivalent power of dozens of horses under the easy and constant control of one operator.*

There is only one

CATERPILLAR
REG U S PAT OFF

HOLT builds it

CATERPILLAR

REG U S PAT OFF

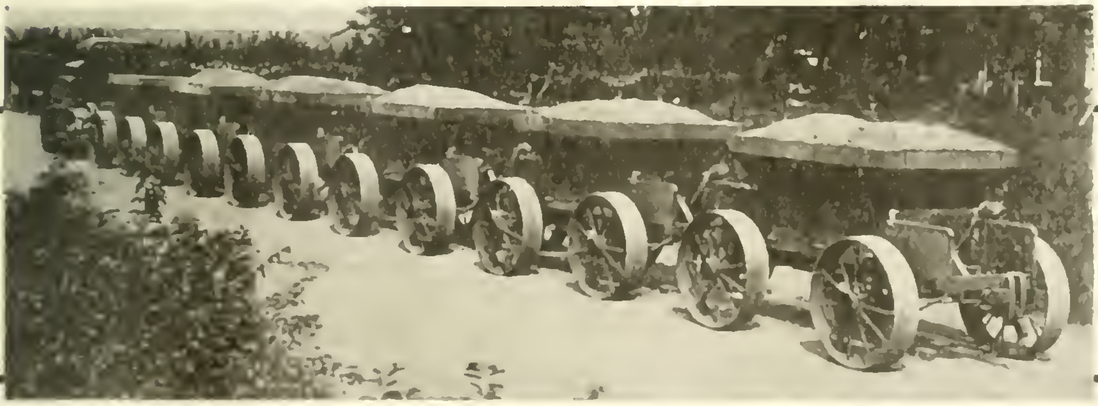
HOLT
PEORIA STOCKTON

The flexible roller frame trucks (an exclusive Holt feature) which carry the entire weight of the tractor, allow the tracks to conform to the unevenness of the ground, enabling the "Caterpillar" to negotiate roughest soils and softest places, yet *the "Caterpillar" will not damage improved highways.*

The three speed transmission provides the proper working speed for clearing, grading, leveling and hauling and insures lowest cost of operation.

The "Caterpillar" has an unmatched record for endurance and economy. Its ability to pull the largest size implements and graders, to operate and turn in narrow cuts, to *work continuously* without being handicapped by soil or weather *makes it the choice of the foremost contractors and road builders everywhere.*

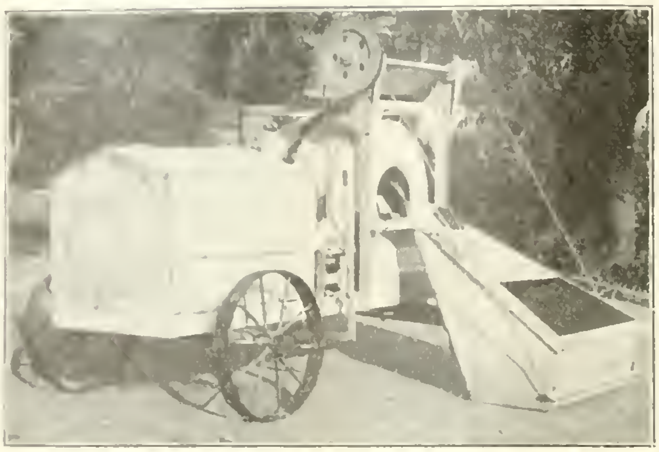
The HOLT Manufacturing Company
Inc.
Peoria, Illinois
Spokane, Wash., New York Office, 50 Church St.
Factories at Stockton, California and Peoria, Ills.



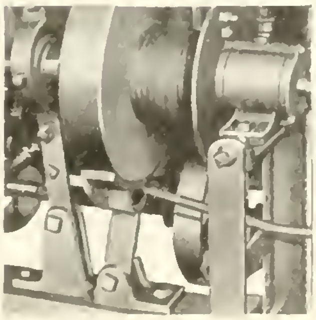
H-9

TRACTORS

GIANT MIXERS

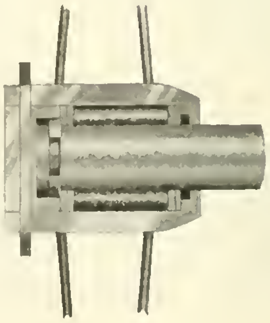


Giant Mixer with Power Loading Skip.



The powerful brake operated by the same lever that operates the clutch. A real automatic kick out when skip is raised to dumping position.

The new drum head construction used on all Giant Mixers. Note the heavy lugs. This new type of construction is far superior to the ordinary types.



Sectional view of hub of Giant Truck Wheel. These bearings, with Giant axle and frame construction, provide a long wearing, easily hauled truck.

The Fastest Discharging Mixer Ever Produced

The patented bucket and paddle construction of Giant Mixers enables the mix to be discharged much faster than in the usual mixer. The paddles throw all of the batch into the buckets—leaving the drum exceptionally clean.

GIANT MIXERS

The Strength of Any Machine Is Measured by Its Weakest Part

IN Giant Concrete Mixers, weak points, skimped parts and faulty construction are as nearly eliminated as is humanly possible. We have endeavored to make our product as lasting and repair-proof as the wonderful "one-hoss shay."

To this end we use roller bearings thruout in Giant Mixers—even to the truck wheels. The drum is perfectly balanced—overcoming the usual vibration that racks and strains the driving mechanism and power plant. All the semi-steel castings are of genuine Charcoal Iron, the sheet metal parts are made only of High Carbon Steel.

The famous patented Giant Mixing action is well known. The extra large buckets and highly developed blades or paddles make Giant Mixers the fastest mixing and discharging machines on the market.

If you are contemplating the purchase of new concrete mixing machinery, our engineering department is at your service. Send for our catalog showing the various models of Giant Mixers and Pavers and the latest price list.

Judy Manufacturing Company

Box 6879 Centerville, Iowa

THE LEE LINE WAY

END DUMP BODIES

For Concrete Paving Work

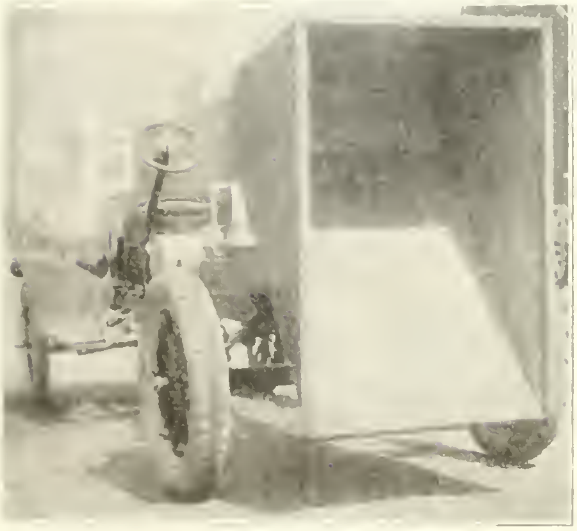
Lee [illegible] hopper [illegible] bodies are built in six sizes: ½, ¾, 1, 1¼, 1½ and 2 cubic yards. Dual hopper bodies [illegible] 2, 2½ and 3 cubic yards **total capacity of two hoppers.** The factory will furnish information about [illegible] hopper bodies for each individual proposed installation.

[illegible] and with intelligent use will last as long as the truck. They [illegible] it known, none have worn out. We have information concerning some of [illegible] operation.

[illegible] parts enter into the construction of one of these single hopper bodies. Practically [illegible] which can be repaired at any blacksmith shop. There are no shafts, bearings, [illegible] or wearing parts to need special parts or fine adjustment in repair.

These Lee [illegible] no mechanical connection with the running parts of the truck. Therefore [illegible] to a stake body—simply set on the frame and clamped down with [illegible] clamps.

[illegible] of body. A short wheelbase truck should be provided, and if necessary [illegible] of rear spring hangers.



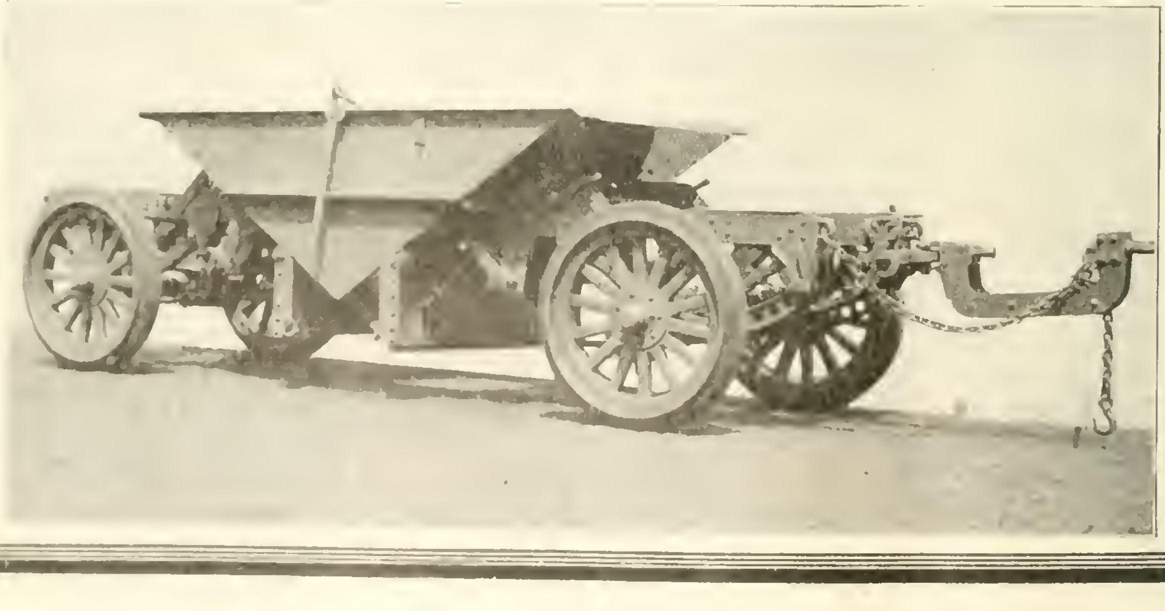
The Road Contractor's Trailer

Dumps and spreads road material.
Body is detachable and can be replaced by a stake bed.

This body is a development stimulated by the wide demand for a trailer body for road building purposes. It is quick of operation, has the advantage of allowing the trailer to be converted quickly to a chassis for use in hauling lumber and other similar materials. The lower portion of the body is flush with the top of the chassis frame while the top is easily removed. The door operating mechanism is built on the lower portion and need not be disturbed. Provision is made to adjust lower doors for spreading materials to various thicknesses. The doors are hand operated and when shut are automatically locked.

Various sizes of trailers and bodies are supplied in this combination outfit.

A road contractor requires flexible equipment of all around usefulness. The Lee reversible trailer with bottom dumping and spreading body is built to fill the contractor's needs.



MAKES MOTOR TRUCKS PAY

SOME 1920 CONCRETE AND ASPHALT PAVING WORK

Typical Examples Selected From Various Parts of the Country.

All of the data shown below are taken from jobs which represent good work, but the selection was not limited to extreme or extraordinary cases. Names of contractors, location of work and further information regarding the job, when available, will be furnished on request.

CONTRACTOR A

Kind of Pavement—Concrete country road.
Width—15 feet.
Method—Dry aggregate.
Equipment—Ford 1-ton trucks with 1 yd. Lee automatic end dump bodies.
Size of Batch—[illegible] bag.
Number of Hours Worked per Day—10 hrs.
Maximum Day's Run—5[illegible]3 lineal ft. or 17[illegible] sq. yds.

CONTRACTOR F

Kind of Pavement—Concrete streets in a small town.
Width—Various.
Thickness—About [illegible] inches.
Method—Dry aggregate.
Equipment—[illegible] Ford 1-ton trucks with 1 yd. Lee automatic end dump bodies.
Haul—From 4 to [illegible] blocks.
Number of Hours Worked per Day—Nine.
Maximum Day's Run—1[illegible] sq. yds.
Maximum Run of 14 Days—17,572 sq. yds., or an average of 1,2[illegible] sq. yds. per day.

CONTRACTOR C

Kind of Pavement—Concrete country road.
Width—[illegible] ft.
Method—Wet mix.
Equipment—Ford 1-ton trucks with [illegible] yd. Lee automatic end dump bodies.
Batch—4 bag.
Mix—1:2:3[illegible].
Maximum Haul—[illegible] miles.

CONTRACTOR H

Kind of Pavement—Concrete country road.
Width—15 ft.
Thickness—8 inches at center.
Method—Dry aggregate.
Equipment—20 Ford 1-ton trucks and additional rented trucks of the same kind, used on the longest hauls, all equipped with 1-yd. Lee automatic end dump bodies.
Batch—4 bag.
Mix—1:2:3½.
Maximum Haul—6 miles.
Number of Hours Worked per Day—Eleven.
Maximum Day's Run—[illegible]28 lineal ft. or 1,[illegible] sq. yds.
Miles Finished During Season—[illegible].

CONTRACTOR B

Kind of Pavement—Concrete country road.
Width—13 feet.
Method—Dry aggregate.
Equipment—2 Clark Tructractors with 1-yd. Lee automatic end dump bodies.
Mix—1:2:3½.
Haul—About 400 ft.

The special feature of interest in connection with this work was that in the middle of the contract a change was made from the wheelbarrow method to the Lee method of charging the mixer, with the result that the crew was cut down from 45 men to 17 men on the job. Space forbids a more complete description of this interesting piece of work. Make-up of the concreting crew was as follows:

2—Grading
2—Truck operators
2—Portable bucket elevator operators
2—Cement men
2—Men setting form
1—Mixer operator
1—Fireman
1—Spout man
1—Finishing machine operator
3—Men covering concrete, etc., etc.

17 Total

An average run of 3[illegible]0 ft. per day was maintained throughout the work. The maximum day's run was 4[illegible] ft.

CONTRACTOR D

Kind of Pavement—Concrete country road.
Width—20 ft.
Thickness—8 inches at center, 7 inches at sides.
Method—Dry aggregate.
Equipment—6 Autocar 2-ton trucks with 2-section Lee automatic end dump bodies, 1 yd. per section. Also from [illegible] to 12 Ford 1 ton trucks with Lee automatic end dump bodies.
Batch—4 bag.
Mix—1:2:[illegible]½.
Longest Haul—4½ miles.
Number of Hours Worked per Day—Nine.
Maximum Day's Run (9 hours)—450 lineal ft. or 1,000 sq. yds.

Calculations show that to make this record run, required the turning out of almost 40 batches per hour continuously throughout the 9-hour day (1000×7½÷36=16.7[illegible] 27[illegible]38.7). This is the fastest possible operation of the mixer when the batch must be kept in the mixer drum a full minute.

Make-up of crew was as follows:

1—Foreman
[illegible]—Men on railroad cars
1—Crane man
3—Measuring box men
3—Cement handlers
1—Blacksmith
1—Auto mechanic
[illegible] to 18—Truck drivers
1—Dump man
1—Mixer operator
1—Spout man
[illegible]—Finishers
[illegible]—Tampers
2—Concrete graders
4—Men setting form
2—Men on light grading
1—Foreman

CONTRACTOR E

Kind of Pavement—Concrete country road.
Width—18 feet.
Thickness—8 inches at center.
Method—Wet mix.
Equipment—Ford 1-ton trucks with Lee automatic end dump bodies.
Batch—4-bag.
Mix—1:2:3½.
Haul—2 set-ups were made on a 7-mile stretch, making a maximum haul of 2 miles.
Maximum Day's Run—543 lineal ft. or 1086 sq. yds.
Maximum 4 Days' Run—2[illegible]6 lineal ft. or 411[illegible] sq. yds., an average of 514 lineal ft. per day, or 10[illegible] sq. yds. per day.

This contractor used a turntable of his own design to turn his trucks around before backing up to the point of discharge on the road. Turntable operation averaged 10 seconds per trip.

Make-up of crew was as follows:

1—Foreman
1—Mixer operator
1—Mixer fireman
1—Crane operator
1—Man on railroad car
[illegible]—Man at charging bins
[illegible]—Cement handlers
3—Hauling cement
3—Men spreading concrete.
[illegible]—Finishing machine operator
10—Truck drivers

[illegible] Total

CONTRACTOR I

Kind of Pavement—Town streets of asphalt with concrete base.
Width—Various.
Thickness of Concrete Base—5 inches.
Method—Dry aggregate.
Equipment—Autocar 2-ton trucks with 2-section Lee automatic end dump bodies, 1 yd. per section.
Batch—2½ sack.
Mix—1:3:6.
Maximum Haul—1 mile.
Number of Hours Worked per Day—Ten.
Maximum Day's Run—2560 sq. yds.
Amount of Work—70,000 sq. yds.

Finished in 48 working days, or an average of 1458 sq. yds. per day throughout the season.

The above work being city paving, it was not required that the conconcrete be mixed in the mixer a full minute. As a matter of fact, intervals between batches were only about [illegible]0 seconds, in some cases [illegible] seconds, which accounts for the very large yardage paid per day.

In addition to hauling the dry aggregate to the mixer in the Lee dump bodies, a large proportion of the asphalt top was hauled in the same manner in the same bodies.

For continued and satisfactory service use the LEE LINE. Write for details

LEE TRAILER & BODY CO.

FORMERLY LEE LOADER & BODY CO.

2331 So. La Salle St. Chicago, Ill.

Quicker Action

Your dump car is the key to successful steam shovel work. **Get rid of your material.** Keep your shovel moving; its time is worth a dollar a minute to you.

The dump car that will dump its load and get back to the shovel quickest; stick to a poor track closest; stand up under hard service longest; and be most **dependable** in its operations under all conditions—that's the dump car which will move the most material for the least money. **The Western is that kind of a dump car.**

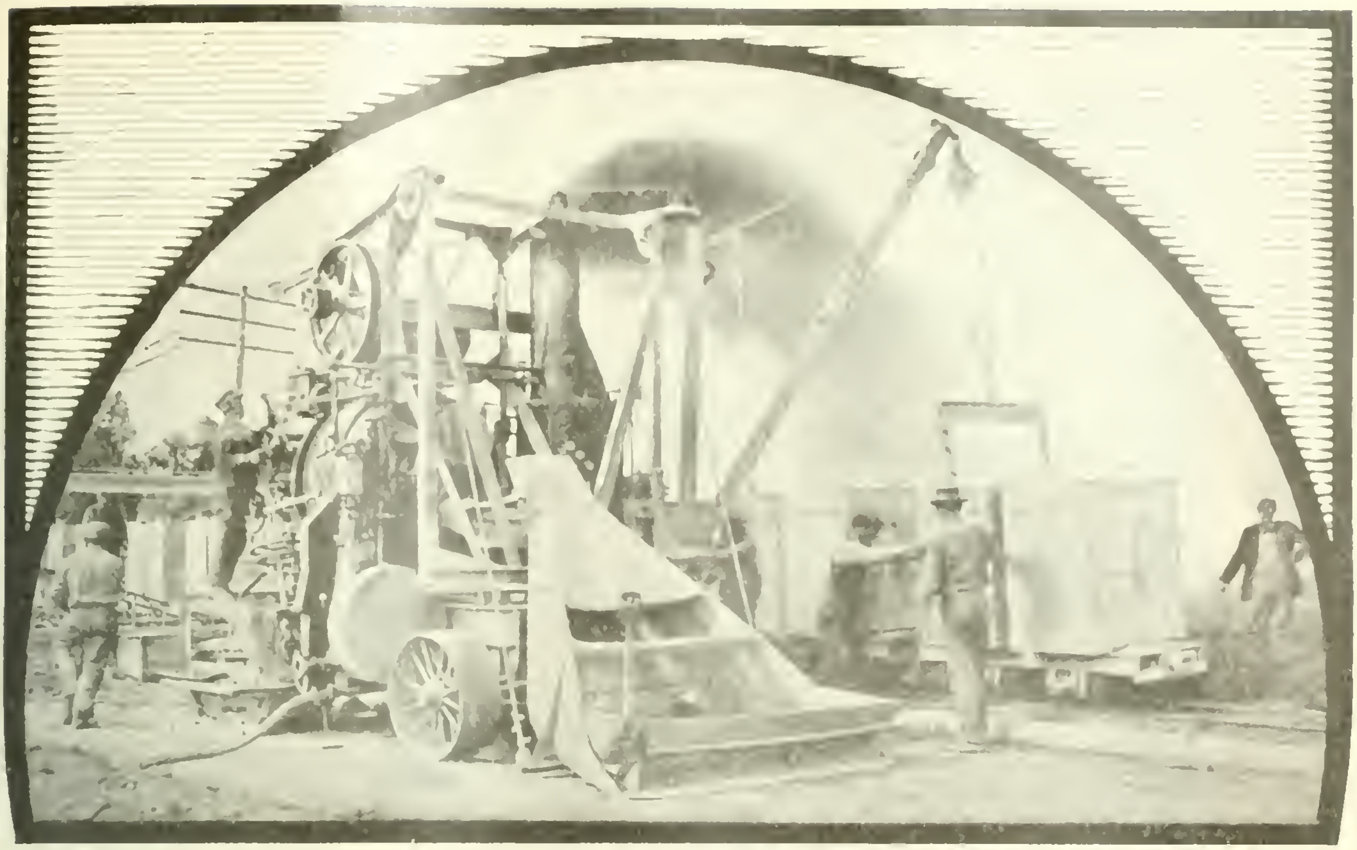
Hundreds of contractors attribute their success to the working qualities and dependability of Western Car equipment.

Tell us your Haulage Problem—material or waste—consulting together we may be able to work out an installation which will **pay for itself** in money saved.

Western Wheeled Scraper Company
Earth and Stone Handling Equipment
Aurora, Illinois, U. S. A.
Founded 1877

Western

WESTERN DUMP CARS
Are the Best the World Produces



Speed Up the Work

The picture above illustrates the Western Batch Box Direct-Charging System of building concrete roads.

No high-priced Labor working around the Mixer. (From 15 to 20 men saved).

No time lost on account of weather. Can start work earlier in the Spring.

(No time lost on account of Mud or Road conditions). (Output increased more than 40 per cent).

No material wasted on the subgrade.

By using Western Batch Boxes and keeping material off your grade you can back fill inexpensively with dirt instead of costly concrete.

Western Direct-Charging System

Western Batch Boxes—built of steel in [illegible] or 2 yd. capacity.
Western Road Builders Truck—1 ton, 24 in. gauge, to carry one or two [illegible] according to size of box.
Fight the high cost of road construction with machinery
Order now, that you may get busy at the first opportunity
For Spring Work NOW. Talk it over with our Road Engineering Department.

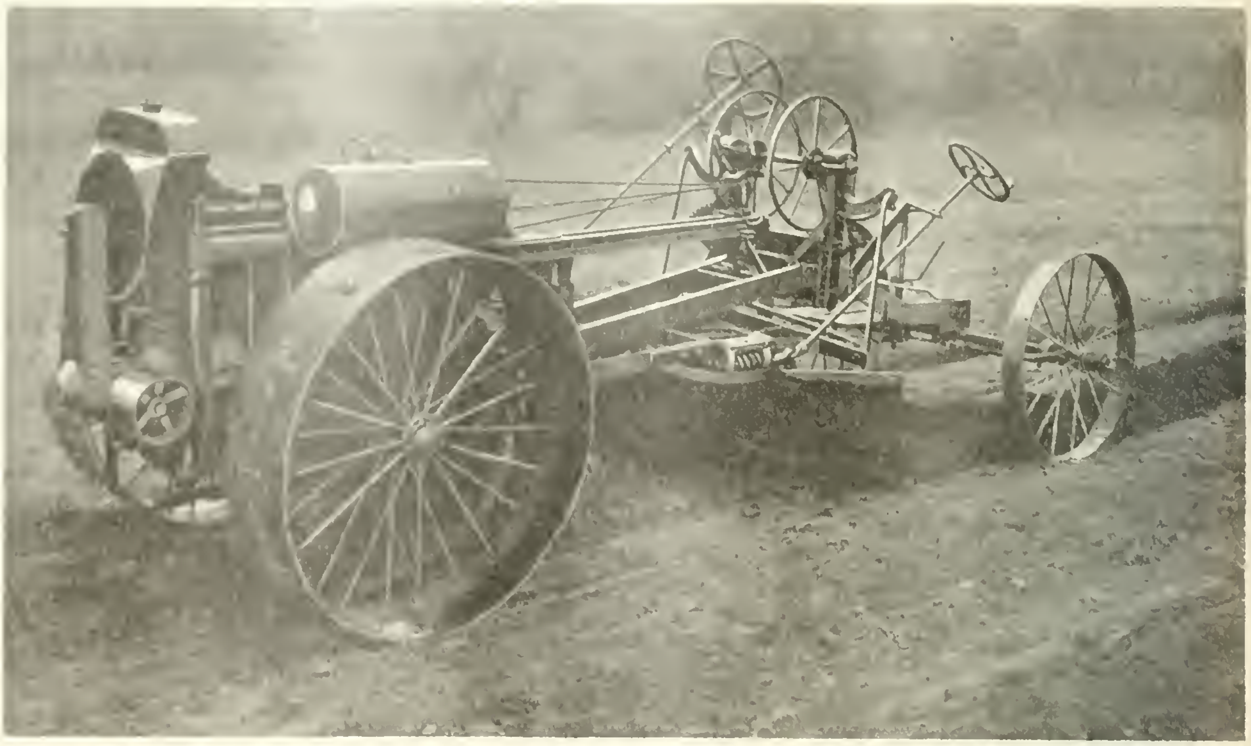
Western Wheeled Scraper Company

Earth and Stone Handling Equipment
Aurora, Illinois, U. S. A.
Founded 1877

Western

WESTERN BATCH BOXES

Will Help Cut Your Costs in Half



THE LITTLE GIANT ONE MAN POWER GRADER UNIT FOR PATROL AND MAINTENANCE WORK

The Little Giant grader equipped with this special tractor attachment is a real one man power grader unit.

It is more economical, serviceable and desirable than the patrol and maintenance units requiring from two to three men to operate.

The operator is closer to his work—he is in complete control of both grader and tractor; a very important feature, especially where large rocks or stumps are encountered. The unit is easily reversed in an emergency.

The Little Giant for years has been the favorite patrol grader of many counties, townships and contractors. Many Little Giants with service records of years are still on the road doing the always dependable work.

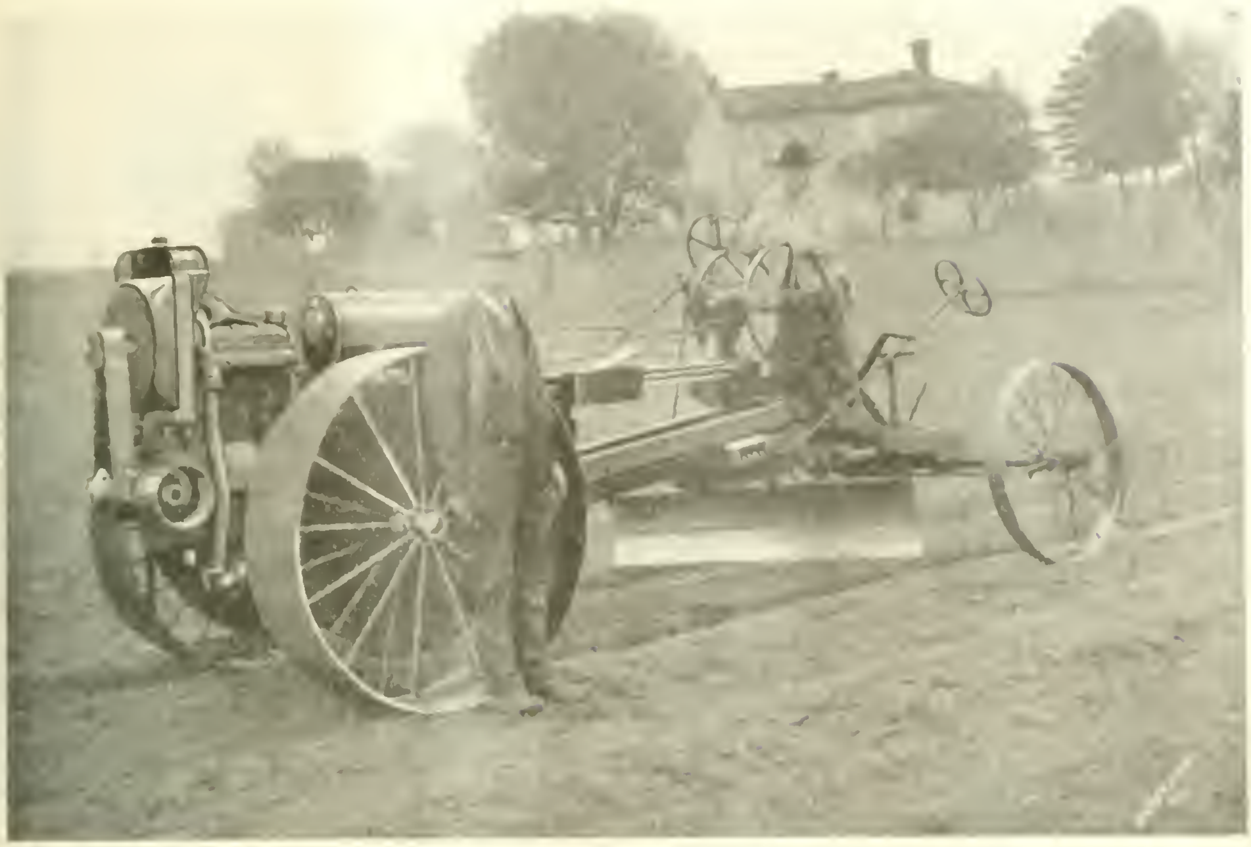
The Little Giant One Man Power Grader is equipped with a 6 foot blade and weighs approximately 1500 pounds. Designed especially for patrol and maintenance work.

We will gladly send you detailed information and prices. We suggest you place your order now with specified delivery date; you will be sure of having your tools when wanted.

SMITH & SONS MA

1504 GUINOTTE STREET

WAREHOUSE STOCKS CARRIED IN PRINCIPAL CITIES



Mr. John Montgomery, contractor, North Kansas City, Mo., and the Little Giant-Moline grader unit he used in laying out the streets in an addition at Claycomo, Mo.

JOHN SAYS: "THE LITTLE GIANT ONE MAN POWER GRADER UNIT IS CERTAINLY A PEACH"

and Mr. Montgomery knows. He has been in the game many years and when he says a machine "is a peach" it means that he has put it to the hardest tests and the machine has proven its worth.

There are FIVE GRADER "PEACHES" in the Royal Quality Line.

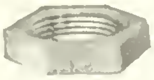
Write for catalog, prices and name of your nearest distributer.

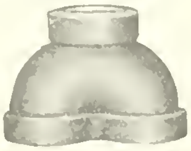
NUFACTURING CO.

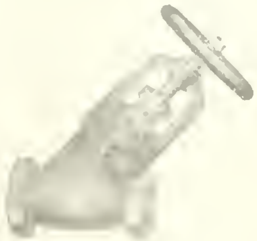
KANSAS CITY, MISSOURI

WAREHOUSE STOCKS CARRIED IN PRINCIPAL CITIES

CRANE



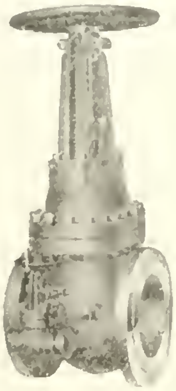




We are manufacturers of about

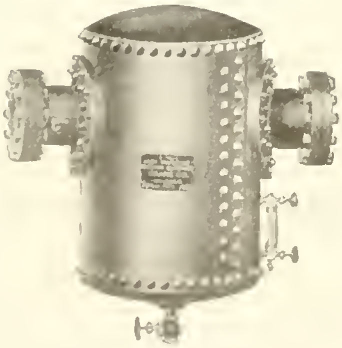
Valves, Pipe Fittings

made of brass, iron, ferrosteel,
all sizes, for all pressures,
distributors of pipe, heating



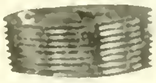
1855——**CRANE**
836 South Michigan

Branches in 62



CRANE

CRANE



0,000 articles, including

nd Steam Specialties

ast steel and forged steel, in
nd all purposes and are
nd plumbing materials.

CO. 1921
Avenue, Chicago

Leading Cities

CRANE

NORTHWEST

Steered Driven—Operated from the Rotating Base by One Man

Will Mount the Pile While Storing Material Under Foot

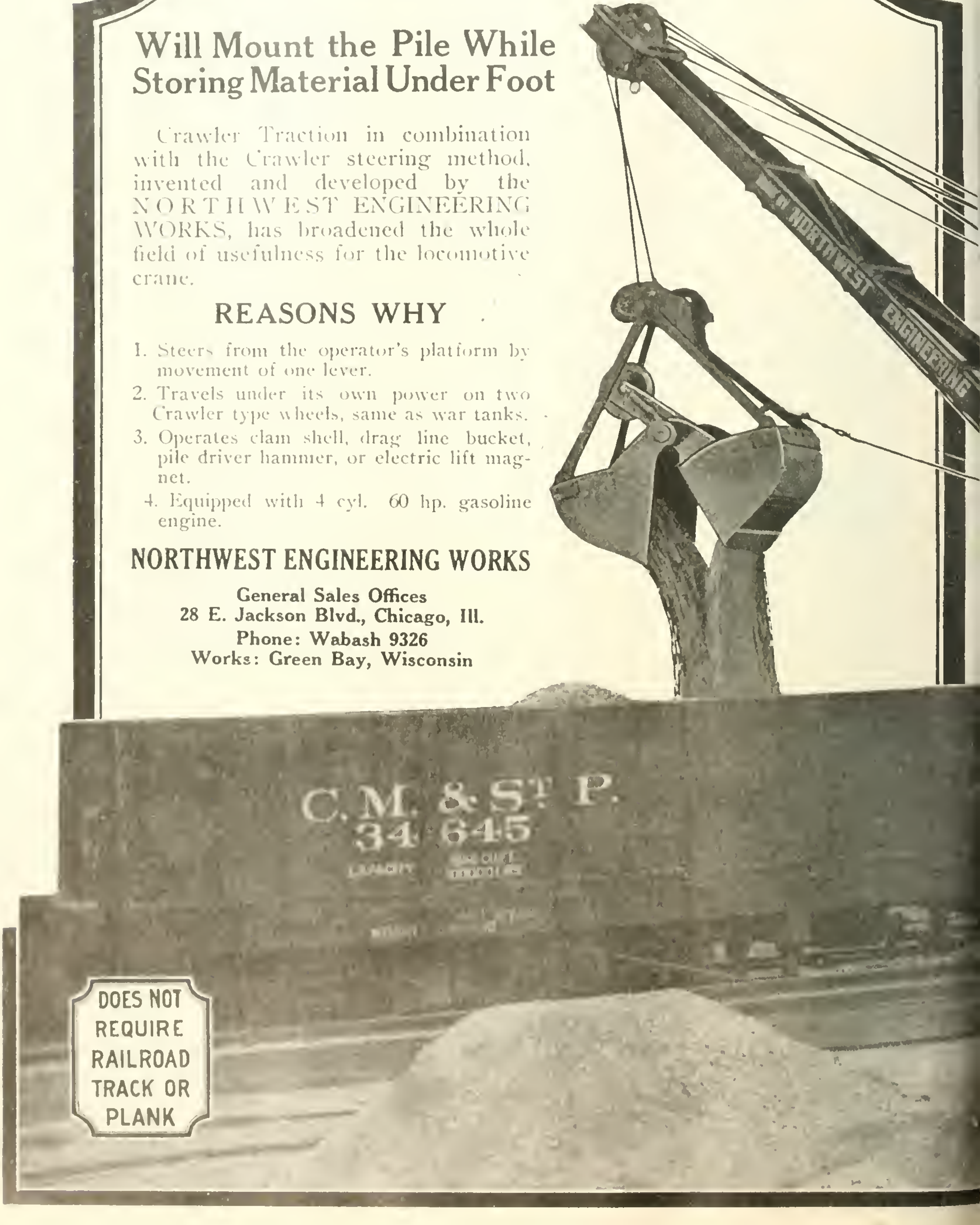
Crawler Traction in combination with the Crawler steering method, invented and developed by the NORTHWEST ENGINEERING WORKS, has broadened the whole field of usefulness for the locomotive crane.

REASONS WHY

1. Steers from the operator's platform by movement of one lever.
2. Travels under its own power on two Crawler type wheels, same as war tanks.
3. Operates clam shell, drag line bucket, pile driver hammer, or electric lift magnet.
4. Equipped with 4 cyl. 60 hp. gasoline engine.

NORTHWEST ENGINEERING WORKS

General Sales Offices
28 E. Jackson Blvd., Chicago, Ill.
Phone: Wabash 9326
Works: Green Bay, Wisconsin



DOES NOT REQUIRE RAILROAD TRACK OR PLANK

NORTHWEST

Steered— Driven Operated from the Rotating Base by One Man

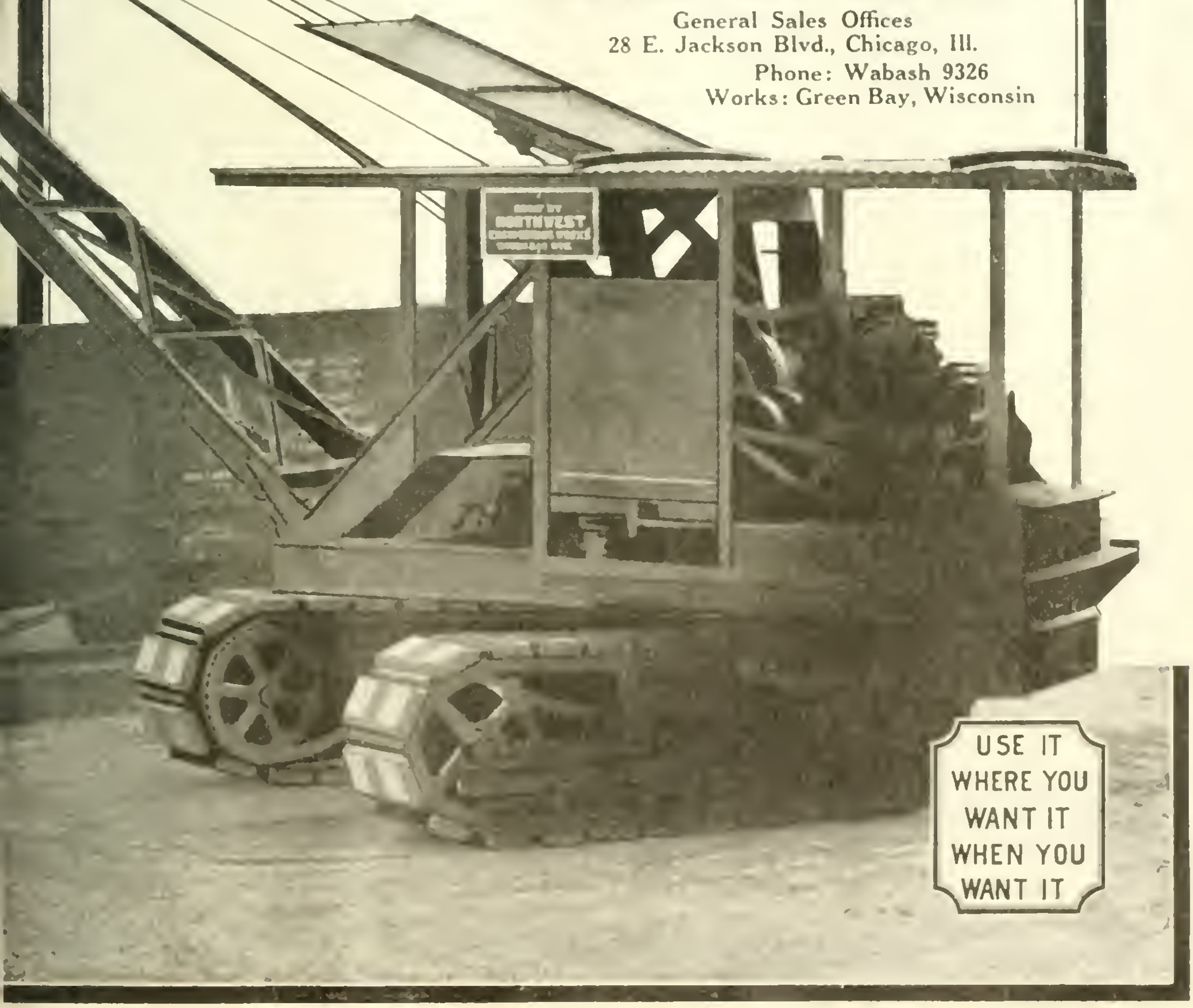
Manoeuvers positively—instantly—up or down grade—to any corner of your yard

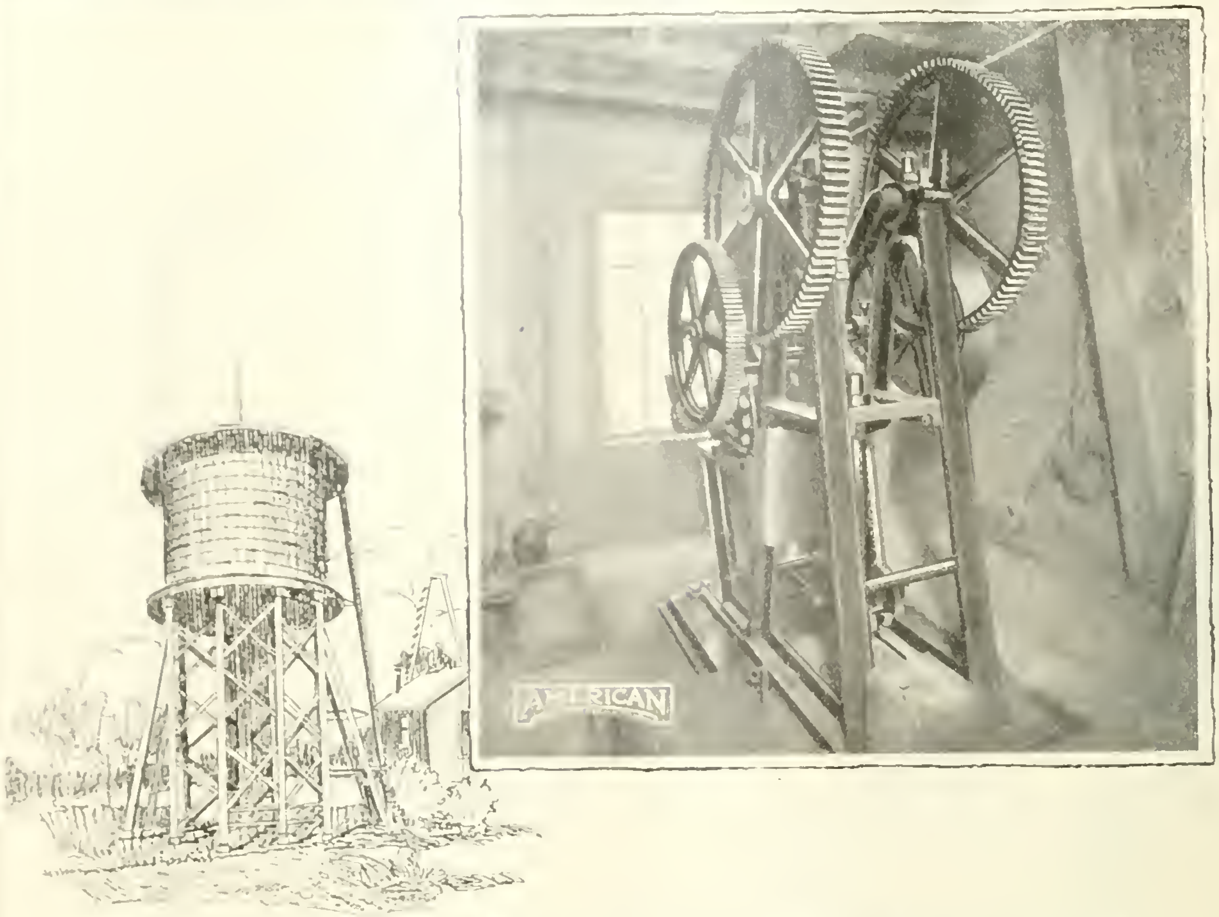
The rugged simplicity of the entire traveling mechanism of the NORTHWEST CRANE enables it to endure the severest service, without replacement of parts, for an indefinite period.

Rotating base revolves through complete circle. Operator can hoist and swing its loaded capacity at the same time.

Entire machinery located beyond the center pin to act as counterweight to the load, thus reducing the total weight, a fact that will be appreciated by those using this crane in mud or soft going.

NORTHWEST ENGINEERING WORKS
General Sales Offices
28 E. Jackson Blvd., Chicago, Ill.
Phone: Wabash 9326
Works: Green Bay, Wisconsin





American Pumps Reduce the Labor Overhead

As builders for fifty years of many designs and types of pumps—the thought constantly in the minds of our engineers has been not only to produce pumps of economical first cost, but also to so design an installation as to reduce the cost of operation.

Because of carefully designed automatic controls, the long life of usefulness which American Pumps enjoy because of their sturdy construction and design is also one of unusual economy from the standpoint of the attendance required.

For instance, the American Deep Well Plunger Pump pictured above, which supplies water to a water tank at Flossmore, Illinois, is manually started, but is automatically shut off by means of a float control. *Constant attendance is not required.*

This American installation replaced an old oil engine equipment, and has been in operation for two years and a half, with a minimum of repairs, due to wear. It supplies 150 gallons a minute from a 10-inch well against 140-foot head—the power being a 10 H. P. motor.

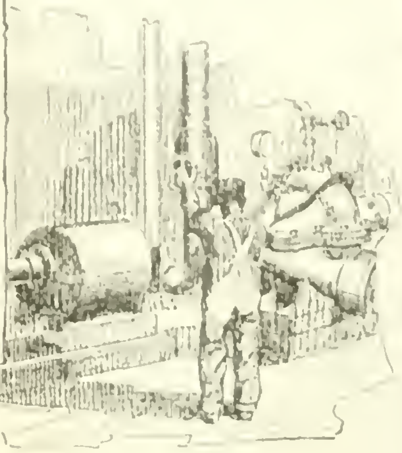
Let our engineers consult with you—they have made a study of the economical installation and operation of centrifugals, deep well plunger pumps and deep well turbines.

THE AMERICAN WELL WORKS

General Office and Works
AURORA, ILL.

Chicago Office
FIRST NATIONAL BANK BLDG

AMERICAN



Six Years of Consistently Good Service—

Back in 1914, The American Well Works installed the steam turbine driven centrifugal pump pictured above, in the Blue Island Power Plant of the Public Service Company of Northern Illinois. The installation is used to take water from the river and deliver it into the general distributing system of the plant—and it is our information that day in and day out for the past six years, it has been giving uniformly reliable service with a minimum of maintenance expense.

The fact is that far from being an unusual case, this installation has simply lived up to the service expected of it. It is natural to suppose that half a century of experience would produce pumps of such quality.

The complete unit is an American 6 inch horizontal, single stage, double suction, centrifugal pump completely bronze fitted, driven by a 53 H. P. split shell Kerr steam turbine, operating non-condensing.

Our engineers will gladly help you solve your plant water supply problems.

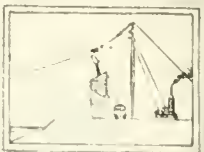
THE AMERICAN WELL WORKS

General Office and Works
AURORA, ILL.

Chicago Office
FIRST NATIONAL BANK BLDG

SAUERMAN DRAGLINE CABLEWAY EXCAVATORS

dig, convey, elevate and dump in one continuous movement, under entire control of one man.



Dumping Material on Spoil Pile

Digging Gravel from Wet Pit

Pond Dug at One Setting

Loading Aggregate on Trucks

Wouldn't this be a good method of handling your next excavating work?

For excavating and handling materials over a large area, the Sauerman Dragline Cableway Excavator is generally the most economical machine to employ, as it does away with the auxiliary conveying system required by other types of excavators.

Its ability to span a distance of 100 to 800 ft. or more and to dig any required depth, elevate, convey and dump in one continuous movement under control of a single operator, has long since established the Sauerman Dragline Cableway Excavator as the most efficient and economical type of equipment for commercial sand and gravel plants.

This same long operating radius and deep digging ability makes our cableway adaptable to a wide variety of operations in the engineering and contracting field. It is being successfully used for excavating reservoirs, removing overburden, backfilling retaining walls, deepening rivers, reclaiming coal and other loose materials from stock piles or storage pits, mining placer deposits, loading ballast into cars, building levees, and so forth.

The experience of our organization of engineers is at your service if you have any work involving excavating and handling materials. Our 130-page illustrated catalog will gladly be sent free on request.

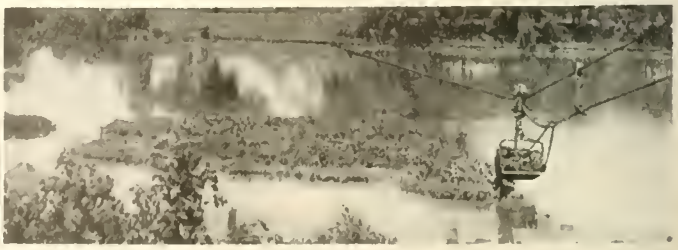
SAUERMAN BROS.
322 S. Dearborn St. Chicago

Deepening and Widening River

Loading Ballast Direct to Cars

Starting to Excavate Reservoir

Handling Coal from Storage Pit



SAUERMAN POWER SCRAPERS

have no superior for working shallow deposits of gravel or excavating material from hill-side

Illustration No. S-1028. *Ready for a new line of operation. This photograph shows the possibilities for cleaning up [illegible] with a [illegible] scraper. In [illegible]*

Illustration No. S-1031. *View of a Sauerman scraper delivering material direct to cars by means of an incline [illegible]*

Illustration No. S-1033. *In one season the 1½ cu. yd. Sauerman power scraper here pictured has handled [illegible] cu. yds. [illegible] from a high [illegible] bank and conveyed [illegible] of about [illegible] feet.*

CONSERVATIVE claims for the smallest sizes of Sauerman Bottomless Power Scrapers, based on the statements of contractors and county road commissioners who are using them, are that a Sauerman scraper operated by one man will displace from 6 to 15 teams and slip scrapers.

The larger sizes of Sauerman scrapers are considered by the commercial gravel producers who use them as being the equal of a small steam shovel with the added advantage that they will not only dig, but also convey the sand and gravel to the plant.

One road superintendent in Michigan who installed one of our ⅓ cu. yd. scrapers in the county gravel pit last summer, writes in to say that it is saving the county $40.00 per day while doing the work that formerly called for a half dozen teams and scrapers.

A Wisconsin sand and gravel producer chose a Sauerman scraper in preference to any other type of equipment when he opened his first gravel pit about six years ago. Today he owns and operates four gravel plants and the excavating and conveying equipment is the same at all—Sauerman Bottomless Power Scrapers.

The many advantages of this one-man operated, combined excavator and conveyor are explained in our Pamphlet No. 10, with illustrations and diagrams of actual installations. A copy of this pamphlet is yours for the asking.

Sauerman Bros., 322 S. Dearborn St., Chicago

If you have a problem of storing or reclaiming coal, here's a special type of scraper to meet your needs.

[illegible]

PIONEERS

There was no Industrial Oxygen before Linde

DAY BY DAY the oxy-acetylene torch plays an increasingly important part in industrial development.

Almost everywhere the welding and cutting flames are speeding production and lightening labor, cutting costs and saving time.

This tremendous boon to industry was made possible by The Linde Company who first produced pure oxygen in commercial volume.

The increasing usefulness of the oxy-acetylene process is made possible by the great Linde organization which not only rigidly maintains the highest standards of purity in oxygen but adequately meets every demand of an ever-growing market.

THE LINDE AIR PRODUCTS CO.
THE LARGEST PRODUCERS OF OXYGEN IN THE WORLD
CARBIDE AND CARBON BUILDING 30 EAST 42ND ST., N. Y.
KOHL BUILDING, SAN FRANCISCO

L-527

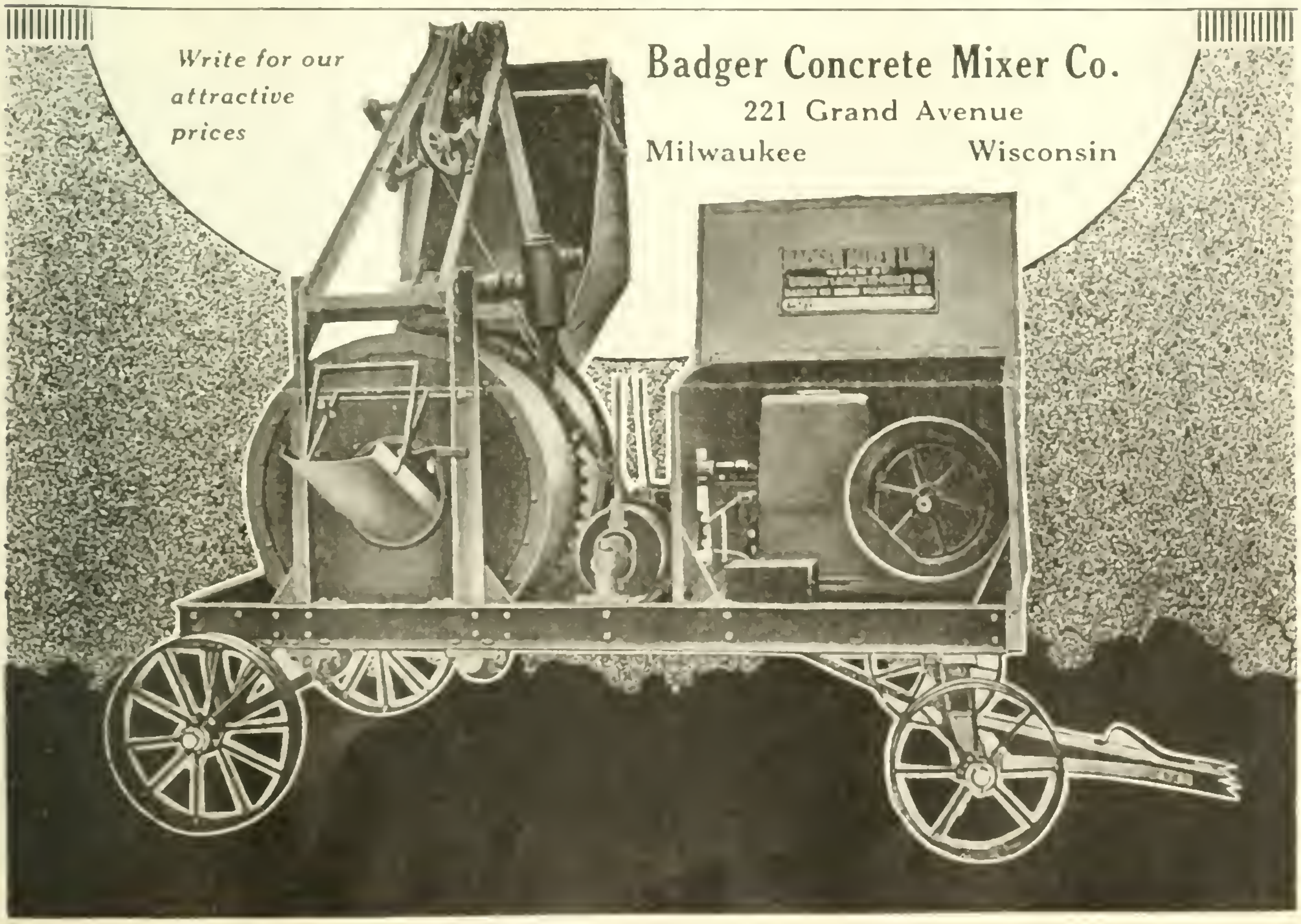
BADGER

The eight years of successful service of our ALL STEEL LIGHT WEIGHT RAPID WORK Badger Mixers with no breakage and little wearing out of parts, has demonstrated the absolute dependability of the Badger Concrete Mixers.

The contractors say that: "The Badger Mixer is always at work on the job and no delays." "That it is light to haul about and never breaks or wears out." "That it is the mixer to buy if you want to perform your contract."

The Nos. 5 and 7 are especially designed for culvert and bridge work as well as sidewalks, curbs and gutters. The Nos. 9 and 11 for foundations and alley paving and the Nos. 15 and 21 for street and highway paving.

The ~ Badger ~ Mixer Line



Write for our attractive prices

Badger Concrete Mixer Co.
221 Grand Avenue
Milwaukee Wisconsin

BLAW-KNOX BLAW-KNOX

Blaw Traveling Heavy Wall Forms

-The cheaper and better construction method—designed and built by the largest manufactures of steel forms in the world

On New York's Subways—traveling form for a massive wall.

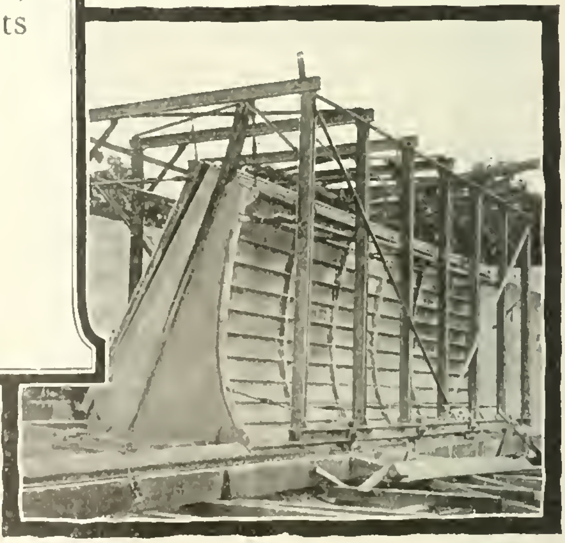
Blaw Heavy Wall Forms

They give you quicker, cheaper and better results when building—

Dams
Piers
Abutments
Retaining Walls
Water Reservoirs
and similar structures

Blaw Heavy Wall Forms are designed and built to meet the requirements of *your* job—we have in stock numerous forms of varied designs and sizes which can perhaps be adapted to your work.

Write for literature.



Water reservoir construction—Specially designed Blaw form for casting curve faced wall

Note:—These products are built and trade-marked by Blaw-Knox Company: Steel Forms for Concrete Construction—Clamshell Buckets—Fabricated Steel Specialties—Water-Cooled Appliances for High-Temperature Furnaces—Pressed, Riveted and Welded Plate Work—Standardized Sectional Steel Buildings

BLAW BLAW-KNOX KNOX

PITTSBURGH, PA.
603 Farmers Bank Bldg.

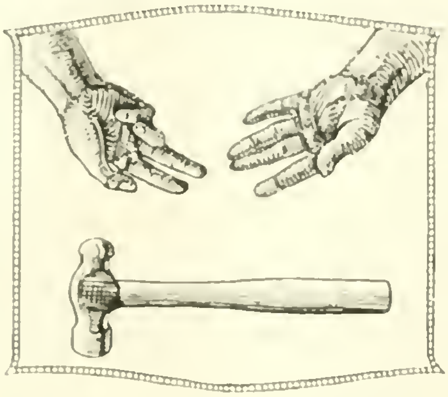
COMPANY

New York-Boston-Chicago-Detroit
Baltimore - Birmingham - San Francisco

TIGER
STEEL BUNKS

At every joint in the TIGER Steel Bunks there is a Boltless Lock. When set in place it holds the frame perfectly rigid. It is as easy to set up as an ordinary Iron Bedstead.

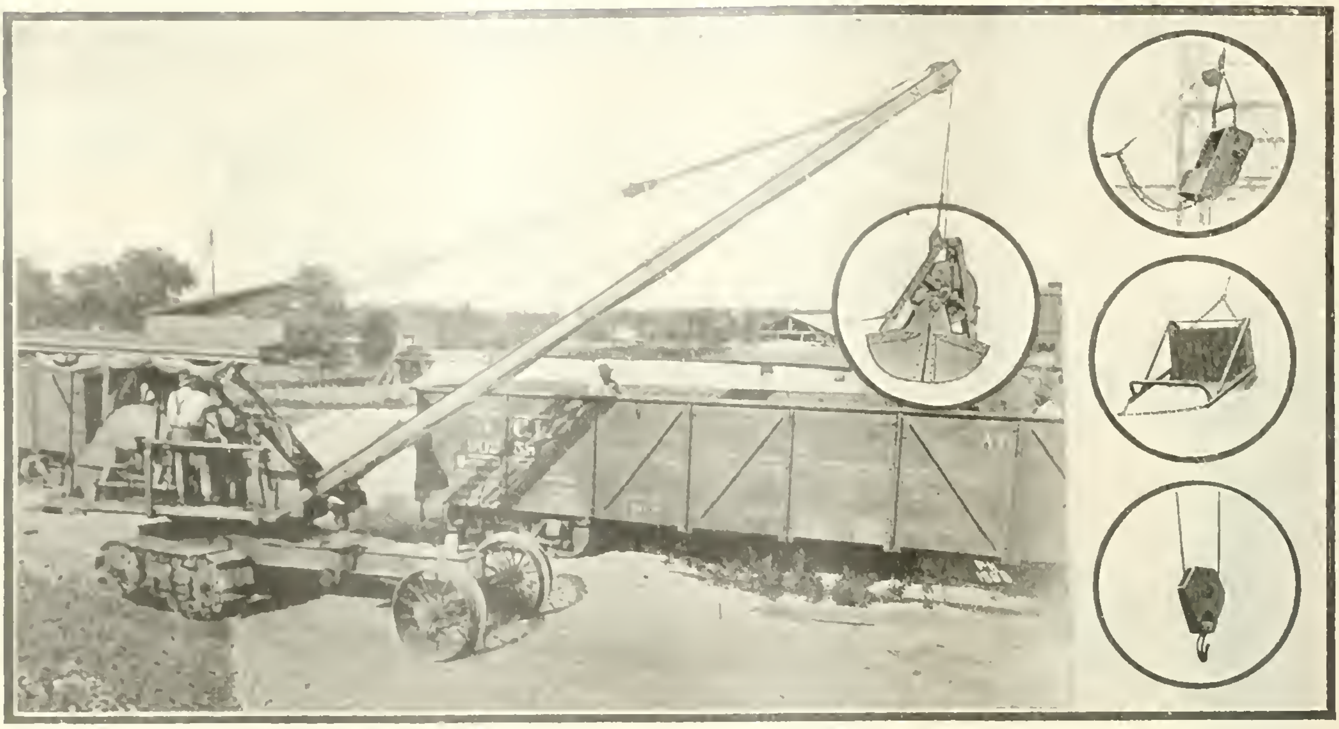
The TIGER Boltless Lock is strong and simple. No brains required. It just goes together naturally. There are no bolts to get loose. No nuts to fall off. It stays where you put it.



The Only Tools Required to Set Them Up.

Made in Single Deck and Double Deck Styles and in Double or Single Widths
Ask for Booklet showing complete line.

HAGGARD & MARCUSSON CO., Established 1887 1116 West 37th St., Chicago



Think of the Possibilities of This Machine

What a multitude of uses it has for the contractor doing general construction work.

Visualize the great saving P & H Excavator Cranes effect in overhead costs as well as the economy of operation.

Consider the design and details of the construction of P & H Excavator Cranes. THEN you will realize just how this combination machine has supplied contractors, engineers and material yard men with a machine capable of a variety of applications at small expense.

P & H Excavator Cranes are of all steel construction; can be shipped without dismantling; require no accessory propping or stabilizing in operation; equipped with non-cloggable corduroys, that permit operation anywhere. They are operated by non-licensed engineers.

We will be pleased to send further information and literature. Ask for it.

Condensed Specifications:

LENGTH OF BOOM: 30 ft., 0 in. BUCKETS: ½ yd. drag, scraper, clamshell, orangepeel. TRACTION SPEED: 1 mile per hour. POWER: 4 cylinder, 5 in. x 6¼ in. 40 H. P. Waukesha. TUBULAR TYPE RADIATOR: Latest heavy truck design. DRAGLINE PULL: 9,500 lbs. SPEED: 100 ft. per minute. SWINGING SPEED: 3 4-10 per minute. DRUM CLUTCHES: Outside Band Friction: SWINGING CLUTCHES: Conical Clutches. All end thrusts in clutches are self-contained and do not come upon bearing.

Lifting Capacities P & H Excavator-Crane

Radius in ft.	Weight	Radius in ft.	Weight
8	15,200	20	5,200
12	9,800	25	3,900
16	6,900	30	3,300

PAWLING & HARNISCHFEGER CO.
EST. 1884
MILWAUKEE, WIS.

50 Church Street, New York
Stephen Girard Building, Philadelphia
Whitney Central Building, New Orleans, La.
Fidelity Building, Pittsburgh, Pa.
Monadnock Block, Chicago, Ill.
Portland, Ore., Yeon Bldg.
Central Building, Los Angeles
Monadnock Bldg., San Francisco
L. C. Smith Bldg., Seattle, Wash.

"You see them wherever you go, and they go wherever you see them"

P&H —excavators,— backfillers, tampers.

BROWNING

The Reach Counts—

Here it means a car loaded to capacity

A CAR shortage demands the *full loading* of every available car. Here's where "Browning" efficiency comes in. Note the bucket—it's in position to load the extreme end of the car solidly, *even on a single track.* And that's only one point in the general all-around service rendered by Browning Locomotive Cranes.

Another big feature in the placing of the controls. These are so located that the operator has the work in full sight all the time, each and every control being handled by him without changing position. The separate rotating engine makes it possible to hoist, rotate and travel, all at the same time—another big time-saving feature.

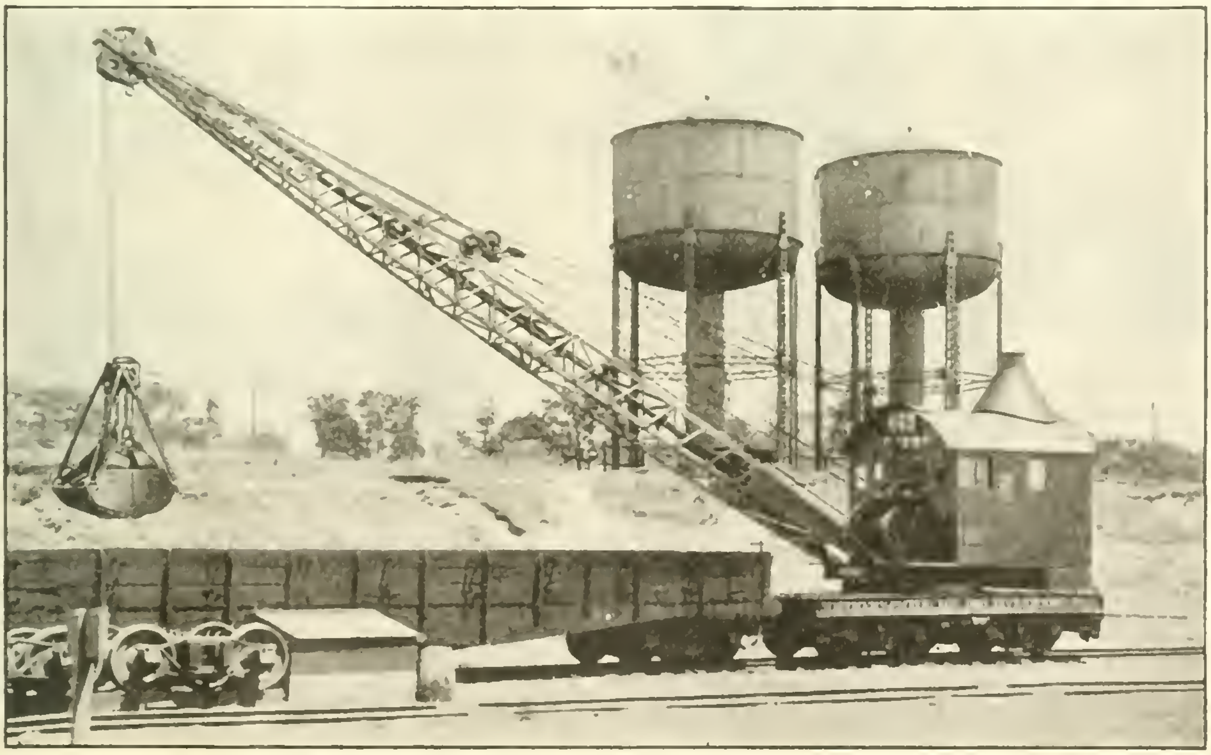
To watch a "Browning" at work is an impressive sight. While apparently as sturdy and unshakeable as the rock of Gibraltar, yet the rapidity of its movements are surprising. "A Giant's strength with a Wizard's deftness," has been aptly applied to the Browning Locomotive Crane.

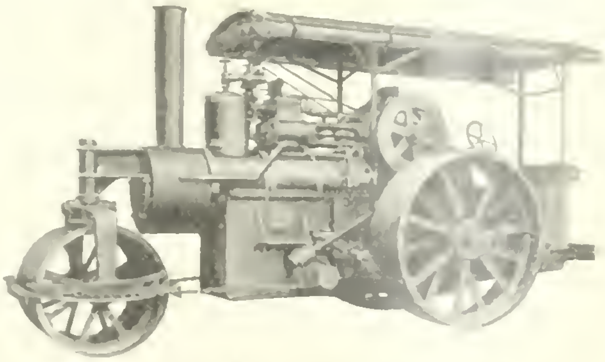
A graphic view of the achievements of the Browning Locomotive Crane in all lines of industry is shown in the Browning Catalog. Your copy will be sent on request.

THE BROWNING COMPANY
CLEVELAND, OHIO, U. S. A.

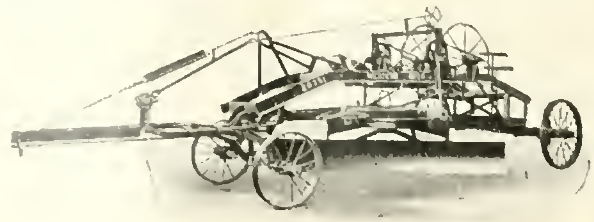
SALES OFFICES:
New York Seattle Salt Lake City Birmingham Los Angeles
Chicago Portland Washington, D.C. Montreal San Francisco

LOCOMOTIVE CRANES

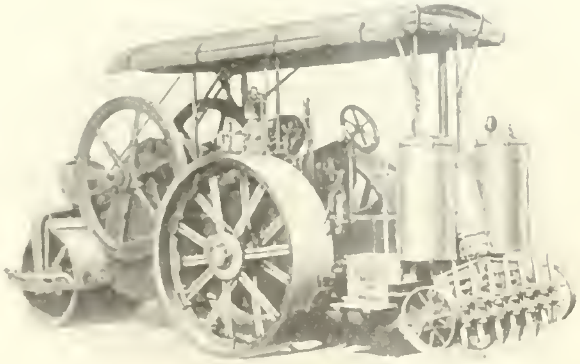




The Austin Steam Roller



Western No. 20 Reversible Road Machine



Austin Motor Roller with Pneumatic Scarifier Attachment

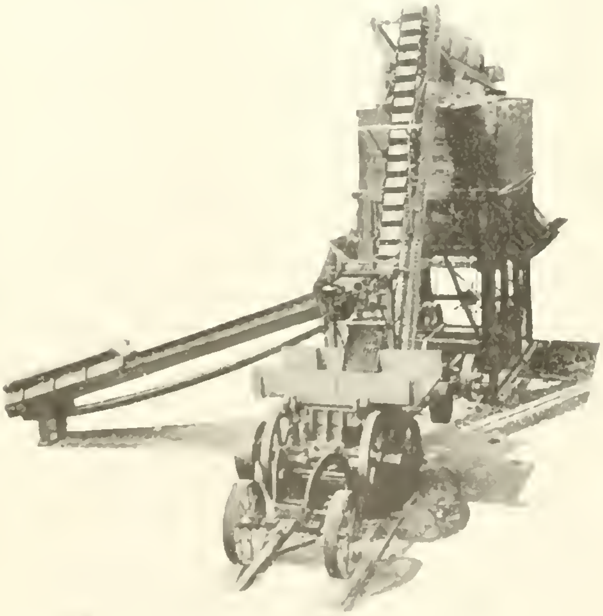
Leading the Advance in Road Machinery

MODERN road building carried out through large projects of a magnitude undreamed of five or six years ago has compelled the remodeling and improving of old-style road machinery as well as the introduction of new types.

The Austin-Western Road Machinery Company, the "Leader of its Line," has maintained that lead not by the introduction of new-fangled or highly experimental machinery, but by the conservative evolution of sound practice, bridging practical experience with modern needs for time and labor saving.

For instance, the Western No. 20 tractor grader, the last word in massive power combined with handiness in operation; the Austin Rip-Snorter, the only practical solution for the old hard macadam road; the Western Portable Gravel Screening Plant, the economical way for securing a local supply of material; the Austin Steam and Motor Rollers with scarifier attachment, the roller with ample power for both construction and maintenance; the Austin Motor Pick-Up Sweeper, sprinkles, sweeps and picks up in one operation any and all kinds of street refuse and dirt.

Every one of the above types embodies recent improvements or entirely new features to meet the demands of the well engineered big road project of today.



Western Portable Crushing and Screening Plant

The Austin Rip-Snorter

THE AUSTIN-WESTERN ROAD MACHINERY CO.

CHICAGO, ILLINOIS

Branch Offices:

[illegible]

[illegible]

[illegible]

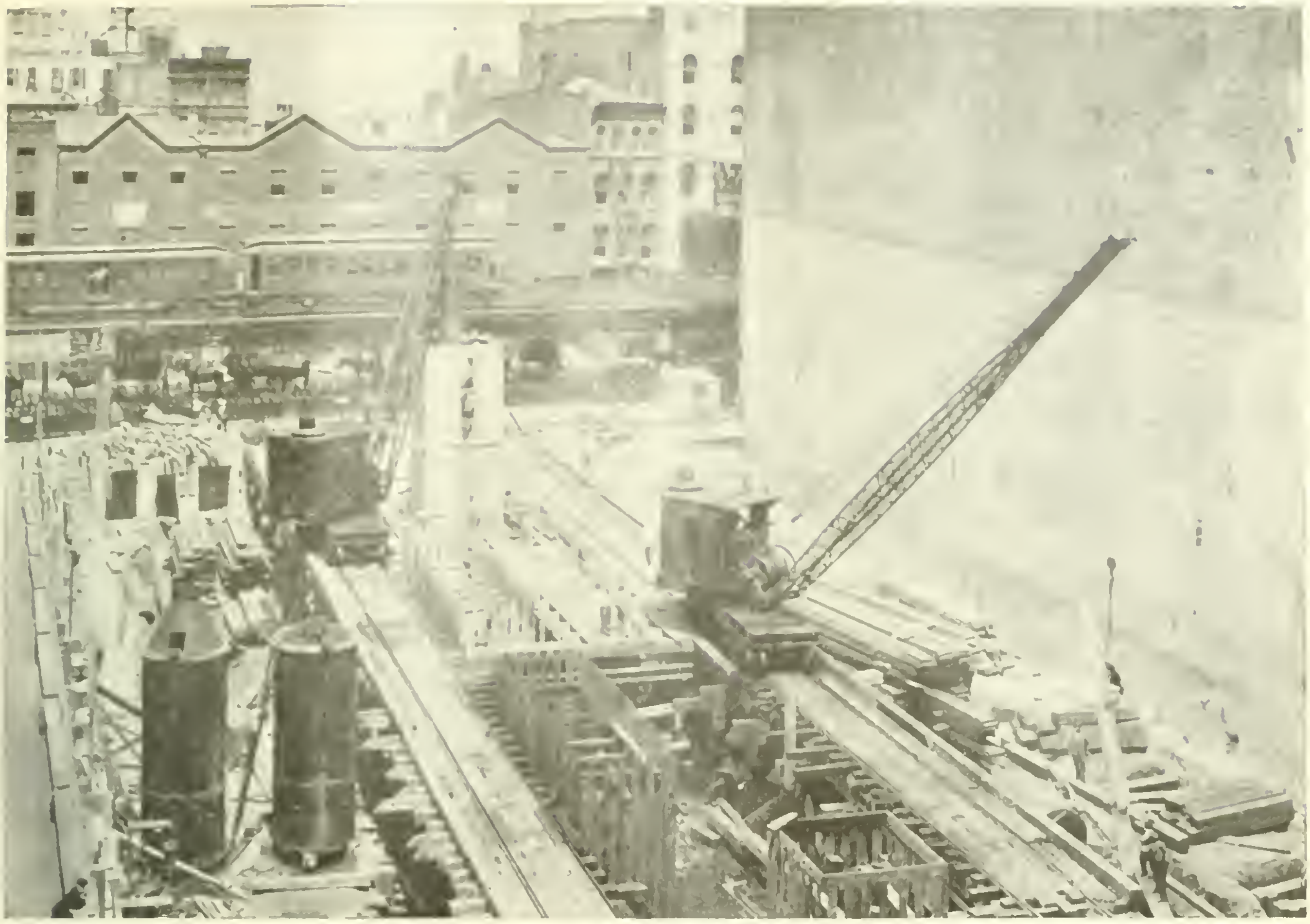
Jackson
Dallas
Oklahoma City

Memphis
Nashville
Atlanta

St. Paul
Portland
Pittsburgh

Los Angeles
San Francisco

EXPORT DEPARTMENT
ALMACOA · ALLIED MACHINERY COMPANY OF AMERICA · ALMACOA
[illegible]



Use labor to the best advantage

Wouldn't it be better to use all your men in jobs which only a man can handle? A great many men are now doing work which could be handled mechanically much more rapidly and economically.

A Brownhoist locomotive crane will enable you to put men at jobs where they are needed. It does most of the work on construction jobs which has been done by laborers. A Brownhoist does all the bucket work such as handling stone, sand and gravel. Besides it drives piles, handles tubs of concrete, forms and reinforcements as well as switching all the cars.

If you have any handling problems, let the Brownhoist engineers solve them for you. They have had 40 years' experience with such problems and will gladly tell you whether you can use a Brownhoist profitably. Catalog K shows the way in which many contractors are using a Brownhoist to advantage on their construction jobs. Write for a copy.

BROWNHOIST

Products Include

Locomotive Cranes.
Grab Buckets.
Drag-line Buckets.
Electric Hoists.
Tramrails and Trolleys.
Overhead Tr. Cranes.
Pillar and Jib Cranes.
Heavy Dock Machinery
Suspended Concrete Bins.

Write for Catalogs

The Brown Hoisting Machinery Company

40 Years in Crane Business

Cleveland, Ohio, U. S. A.

Engineers and Manufacturers of Heavy Dock Machinery, Bridge Cranes, etc., as well as smaller Cranes and Hoists.

Branch Offices in New York, Pittsburgh, Chicago and San Francisco.
European Representatives: H. E. Hayes, 12 Rue de Phalsbourg, Paris

DEPENDABLE CRUSHING MACHINERY WHERE AND WHEN YOU WANT IT

The importance of a continuous and reliable supply of crushed materials in road building need not be emphasized. A mishap to the quarry crushing plant or a break in the line of transportation of this essental material means suspension of work, costly delays and dissatisfaction to all concerned. This prolific source of expense and lost time is positively and permanently eliminated by the

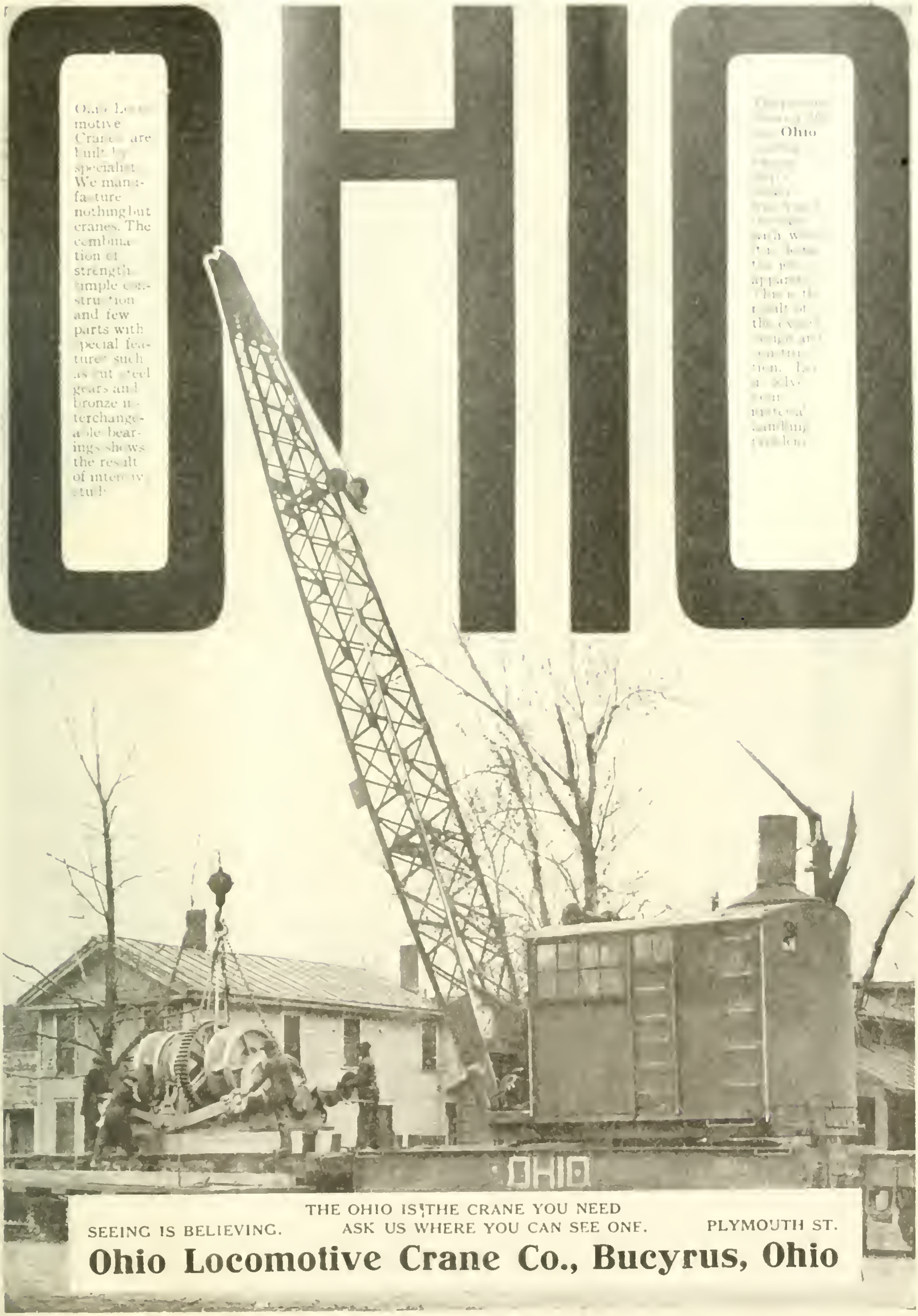
GRUENDLER STANDARD
Portable Road Crushing Plant

The entire outfit including Crusher, Elevator, Bins and Screens are mounted on strong trucks and can be moved anywhere. Rugged Gruendler Construction makes this powerful unit as strong and solid as any stationary crushing outfit. The crusher is of the powerful Swing Hammer Type and will crush all road materials to any fineness. This machine is made for hard, continuous service under any and all conditions and insures a reliable and constant supply of crushed material at all times and at the place it is desired. Where raw material is available near location of work the elimination of long hauls from quarry or crushing plant is one of many appreciable economies made possible by this machine. Considered from any angle, the Gruendler Standard Portable Crushing Plant is the logical solution of this important problem.

Your Inquiry Is Cordially Invited

GRUENDLER PATENT CRUSHER AND PULVERIZER CO.

921 North Main St., St. Louis, Mo.



Ohio Locomotive Cranes are built by specialists. We manufacture nothing but cranes. The combination of strength, simple construction and few parts with special features such as cut steel gears and bronze interchangeable bearings shows the result of intensive study.

[illegible] Ohio [illegible] This is the result of the expert design and construction. Let us solve your material handling problems.

THE OHIO IS THE CRANE YOU NEED
SEEING IS BELIEVING. ASK US WHERE YOU CAN SEE ONE. PLYMOUTH ST.

Ohio Locomotive Crane Co., Bucyrus, Ohio

Most Popular Steam Shovels for General Class Contracting Work

For the general every-day use on contracting work such as Road Grading, Cellar Excavating, Sewer Trenching, Railroad Work, Loading and Unloading Cars, Working in Gravel Pits, Brick and Clay Yards, Stone Quarries, Stripping, Ditching, Dredging, Etc., you get the greatest amount of shovel satisfaction in every way when you buy an Osgood.

We will take pleasure in furnishing to any request complete information on any of the different size shovels we build, which range from three-fourths to six cubic yards capacity.

Write today for copy of General Catolog B-2.

OSGOOD 29 AND OSGOOD 18

THE OSGOOD COMPANY
MARION, OHIO

WELL DRILLS AND EXCAVATORS
TRADE MARK
KEYSTONE
REGISTERED U. S. PATENT OFFICE
KEYSTONE DRILLER CO., BEAVER FALLS, PA.

TRACTION EXCAVATOR

---

12 Ton ½ Yd.

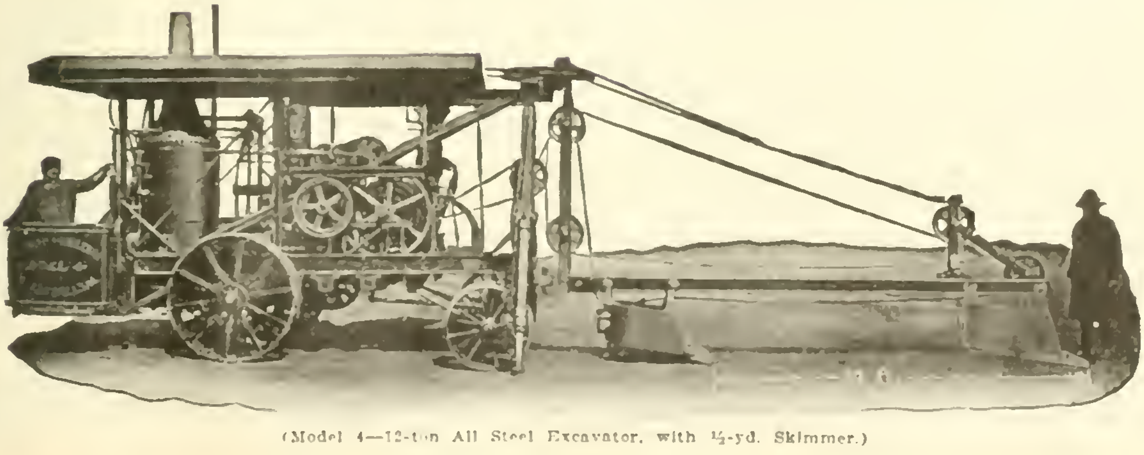
IT is a *light, traction* shovel (steam or electric), usable with four different, interchangeable scoops—*Skimmer, Dipper, Drag Ditcher* and *Clam-Shell*—for Road Grading, Trenching, Backfilling, Cellar Digging, Pit Mining, Loading, Unloading and Handling Materials.

Saves first cost, moving cost and upkeep, and is readily sold or rented for any sort of excavation job. There are 1000 Keystone Excavators in use.

A reliable road shovel of remarkable adaptability to other uses.

KEYSTONE DRILLER CO.
BEAVER FALLS, PA.
170 Broadway, NEW YORK Monadnock Bldg., CHICAGO
JOPLIN, MO.

Makers of
Keystone Well Drills and Excavators
Downie Deep Well Pumps



(Model 4—12-ton All Steel Excavator, with ½-yd. Skimmer.)

A Jordan Keeps Traffic Moving

A Jordan with switch engine and one man removes all snow and flanges solid ice in yards or on running lines.

When the snow season has passed the Jordan ditches, spreads and levels banks.

The Jordan Spreader

"Does the work of an army of men"

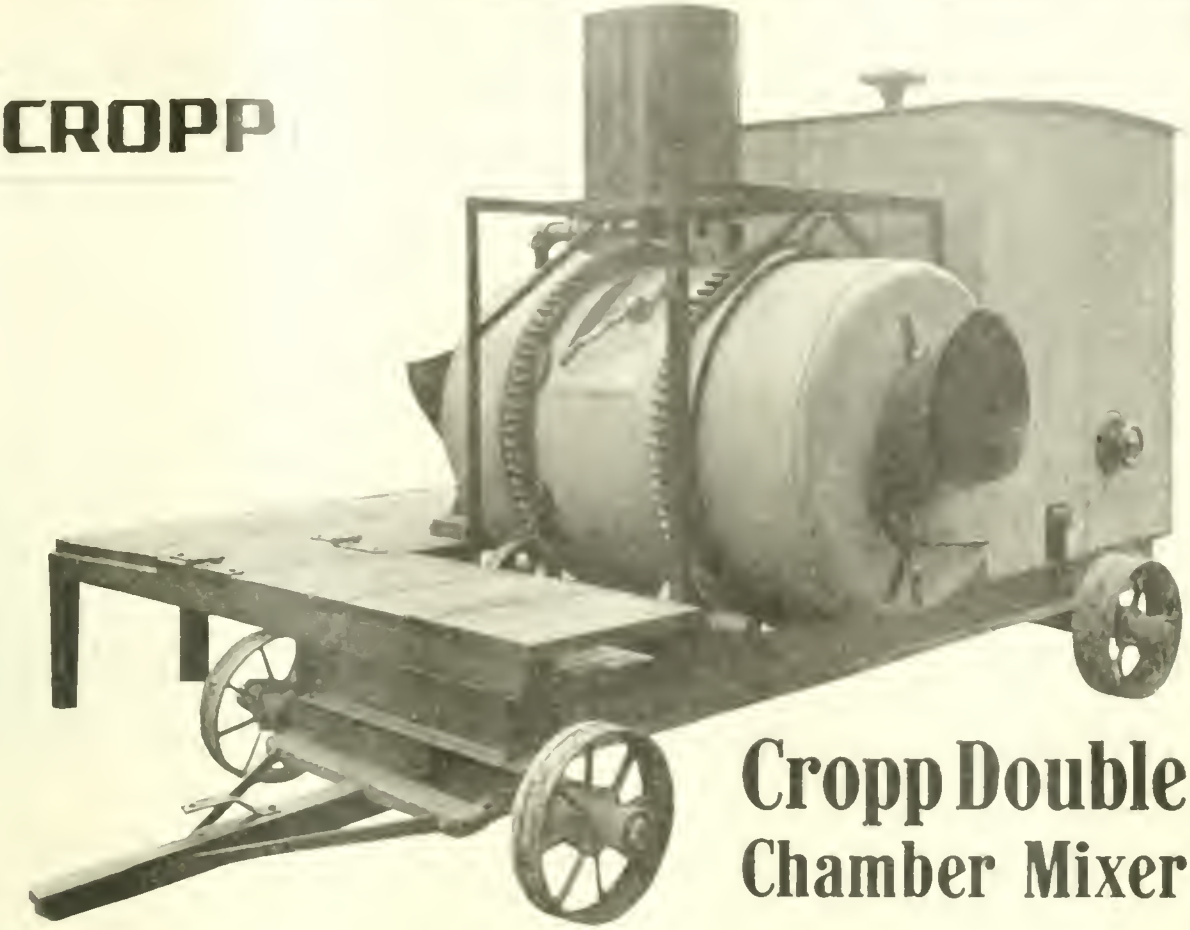
It Spreads, Plows, Flanges, Scrapes, Grades; Levels Sand, Snow, Clay, Ballast, Rock, Slag, Debris, Coke, Coal, Ore.

Jordanize---Economize

Investigate the Jordan today. Let us tell you where it is being used and how many of the large Railroads and Industries are cutting costs with the Jordan Spreader.

O. F. JORDAN COMPANY
EAST CHICAGO, IND.

CROPP



Cropp Double Chamber Mixer

¶ The three distinctive features---Low Charge, High and Rapid Discharge, and Double Chamber---give a larger output of mixed concrete than any single chamber mixer of same rated capacity.

¶ *Not a Continuous Mixer,* but a *Continuous Succession of Separate Batches,* mixed and poured with a smoothmess of operation that eliminates the usual awkward delays.

¶ Compact, powerful, with low headroom, the Cropp Double Chamber Mixer for ten years has worked successfully under all conditions, has been the answer to large. yardage requirements.

The practical contractor will want to test the proved advantages of Cropp features.

WRITE

B. M. CROPP COMPANY
Factory and Warehouses
2340 West Kinzie Street
CHICAGO, ILLINOIS

Whether it's boxes or bales, cases or cartons, barrels or buckets, bundles or bags, lumber or bricks, castings or pigs, there's a Mathews Gravity Roller Conveyer system that our engineers can fit your plant and needs—profitably.

Use More of Your Power For Production Gravity Will Do the Hauling

The power and the labor you now use for hauling and conveying can be put to better use. Throw them into the breach that the necessity for greater production has made. Mathews Gravity Conveyers will do the hauling, do it more efficiently, without pay and without power.

The illustration above shows a part of the Mathews solution to the varied problems of the Aberthaw Construction Company, of Boston, Mass. Whether your problem is indoors or out, no matter what you have to carry, the Mathews answers practically every conveying purpose.

Around corners, from floor to floor, from building to building—the Mathews will feed your workmen with materials till the job is finished. And then—off to the next one.

The ball-bearing rollers of the Matthews Gravity Conveyer are made of seamless drawn steel. It is built sectionally; can be installed permanently or used portably. Solving conveying problems is a business with us. One of our sales engineers is in your vicinity and will be glad to discuss yours with you. Write for our new catalog showing a wide variety of our installations.

The Mathews Gravity Carrier Co.
142 Tenth Street :: Elwood City, Pa.
Branch Factories: Port Hope, Ontario—London, England

Member of Material Handling Machinery Manufacturers' Association

MATHEWS
SPEED ECONOMY
GRAVITY ROLLER CONVEYER

WEBSTER

CONVEYING AND ELEVATING EQUIPMENT

SERVICE

THERE is no more intensive industrial engineering than equipping buildings with coal and ash handling mechanism, for elements of economy as well as quality are involved. Webster equipment means true economy because it lowers the cost of operation.

Webster engineers thoroughly understand coal and ash handling machinery and design equipment that is exactly fitted to the specific work it is called upon to do. As the years go by, the slight wear and tear on the machinery demonstrates how rugged Webster equipment really is—and how it delivers maximum service value at minimum maintenance cost.

This is why Webster coal and ash handling equipment is specified by buildings that are known for efficient operation.

WEBSTER

THE WEBSTER MFG. COMPANY

4500-4560 CORTLAND STREET
CHICAGO

FACTORIES CHICAGO AND TIFFIN, OHIO.

SALES OFFICES IN PRINCIPAL CITIES

*The
Successor
to
Pick
and
Gang
Labor*

*Breaking
Concrete
Prepara-
tory to
Digging
the
Trench*

The Buckeye Concrete Breaker

Cutting 15.7 Feet of Concrete or Asphalt per Minute

This is what the Buckeye Concrete Breaker does. **It does the work of a gang of laborers, does it more quickly and efficiently, and saves the contractor that much expense in wages.**

This automatic machine is designed and built for the trenching contractor engaged in municipal work. The 1100-pound hammer makes approximately fourteen strokes per minute, with a sidewise travel of six feet. Ample power is provided with a 15 h. p. valve-in-head engine.

In Detroit two of these machines have justified our claims that they will pay for themselves in a short time in any municipality.

Complete information on request.

Buckeye Model "C" Excavator

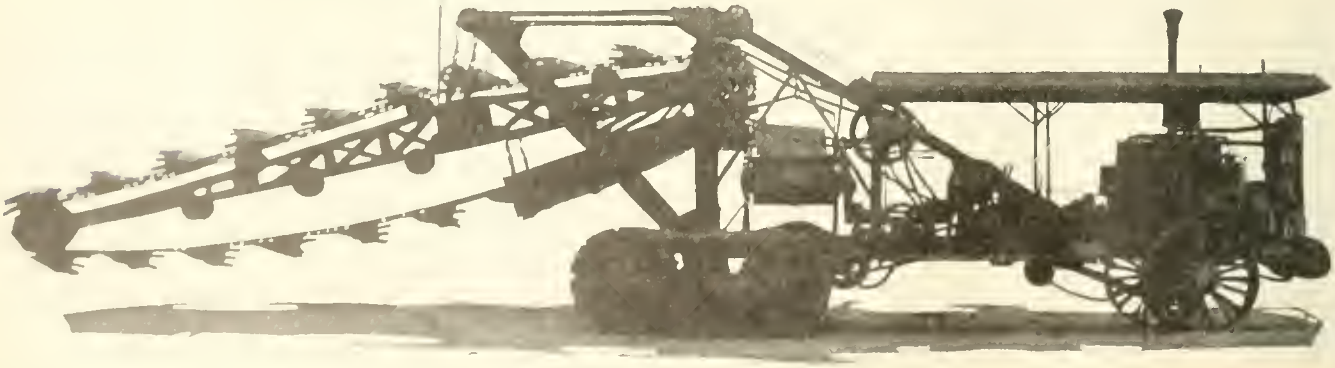
Chain and Bucket Type

Following in the wake of the Concrete Breaker, the Buckeye Model "C" Excavator takes up the work where the breaker left off, and sinks the trench cleanly to any desired depth up to 15 ft. In width it is equipped to dig 24, 28 or 36 inches. To the municipal contractor the Buckeye Model "C" is an invaluable asset, working efficiently in any soil and displacing a great deal of hand labor.

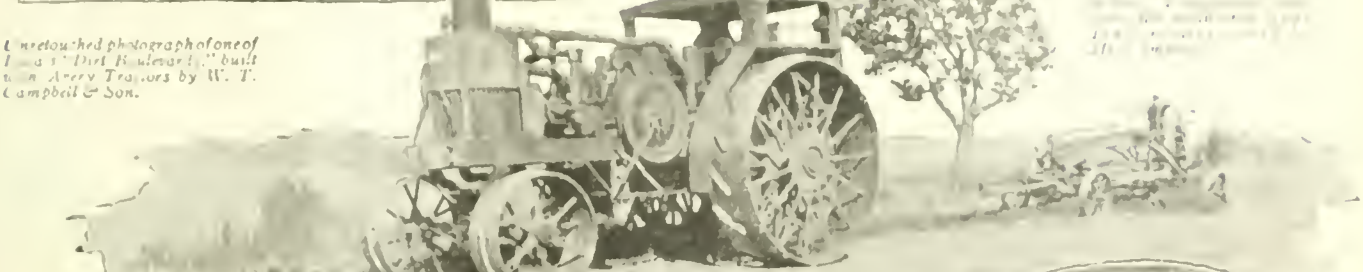
Consult with our engineers on your particular problem. Full information on request.

The Buckeye Traction Ditcher Co.

Findlay - - - - Ohio



Unretouched photograph of one of Iowa's "Dirt Boulevards," built with Avery Tractors by W. T. Campbell & Son.



[illegible]

No. 2

Building "Dirt Boulevards" With Avery Road Tractors

A few years ago W. T. Campbell & Son of Council Bluffs, Iowa, purchased an Avery Road Tractor. It did such satisfactory work that they purchased another and another until today they have six of these great power units at work in Iowa, building "Dirt Boulevards," the finest dirt roads in America.

Avery Road Tractors are doing the same fine work in building good roads on all sides of the globe. Ten years of actual service has made them the world's champion road building tractors. On account of their greater simplicity and durability, they stand up under hard road building work better than any other power, giving service at the lowest possible cost.

Avery Road Tractors are guaranteed to build your roads 50 per cent cheaper than the same work can be done with horses or mules, and also do it better. This means cutting your road building costs in two, or building *two* miles of *better* roads for your present cost of *one*.

Road building is about the hardest test to which a tractor is put. Avery superiority in this field may be partly attributed to its sturdy "Draft-Horse" motor and "Direct-Drive" transmission—two features especially made for heavy-duty work. Other exclusive features are Renewable Inner Cylinder Walls, Adjustable Crankshaft Bearings, practically Unbreakable Crankshafts, Centrifugal Gasifiers, Valves-in-Head, etc.

There are seven sizes of Avery Tractors—each having these exclusive and protected features. Write for Special Road Tractor Catalog and learn more about the Avery Line of Champion Road Building Tractors.

Avery-ize Your Roads—"Better Roads at Less Expense"

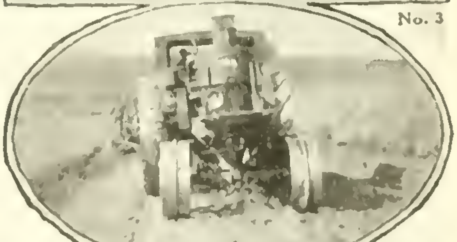
AVERY CO., Factory and Main Office, **Peoria, Ill.**

Branch Houses: Madison, Fargo, Omaha, Minneapolis, Grand Forks, Sioux Falls, Aberdeen, Billings, Lincoln, Sidney, Davenport, Waterloo, Des Moines, Indianapolis, Columbus, Kansas City, Wichita, Stuttgart, Los Angeles, and Sacramento

Distributors: Avery Company of Texas; Dallas, Amarillo and Beaumont, Texas. Avery Machinery Co., Denver, Colo.

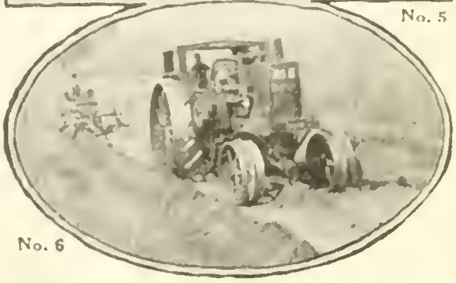
Also Other Principal Machinery Centers

No. 3



No. 4

No. 5



No. 6

AVERY

Tractors, Trucks, Motor Cultivators,
Threshers, Plows, etc.

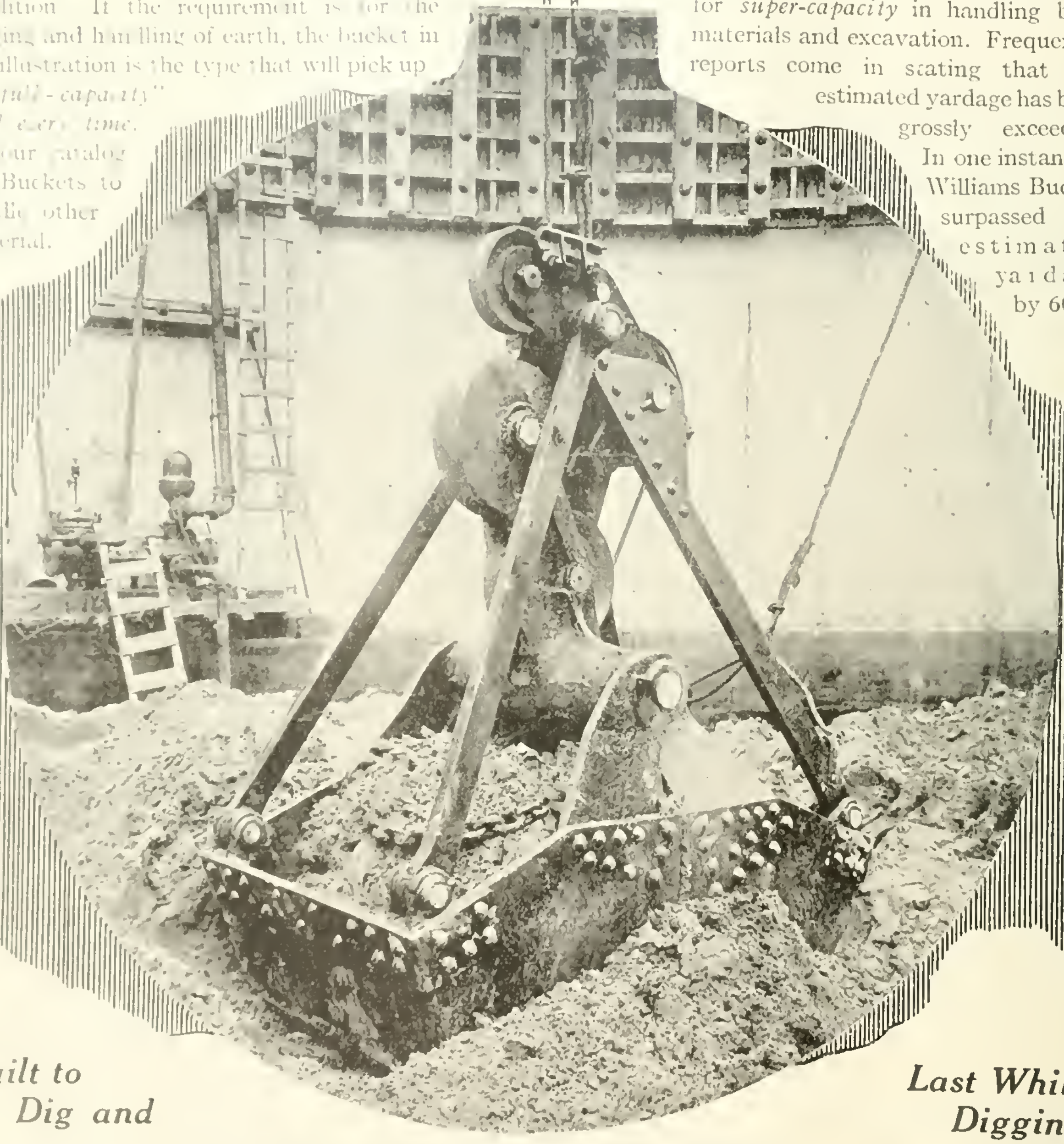
Of Course It's a

WILLIAMS BUCKET

The Bucket That Bites Deep and Hard and Never Gives Out

We have a bucket to meet practically any condition. If the requirement is for the digging and handling of earth, the bucket in the illustration is the type that will pick up a "*full-capacity*" *load every time.* See our catalog for Buckets to handle other material.

Williams Buckets have made a record for *super-capacity* in handling bulk materials and excavation. Frequently reports come in stating that the estimated yardage has been grossly exceeded. In one instance a Williams Bucket surpassed its estimated yardage by 60%.



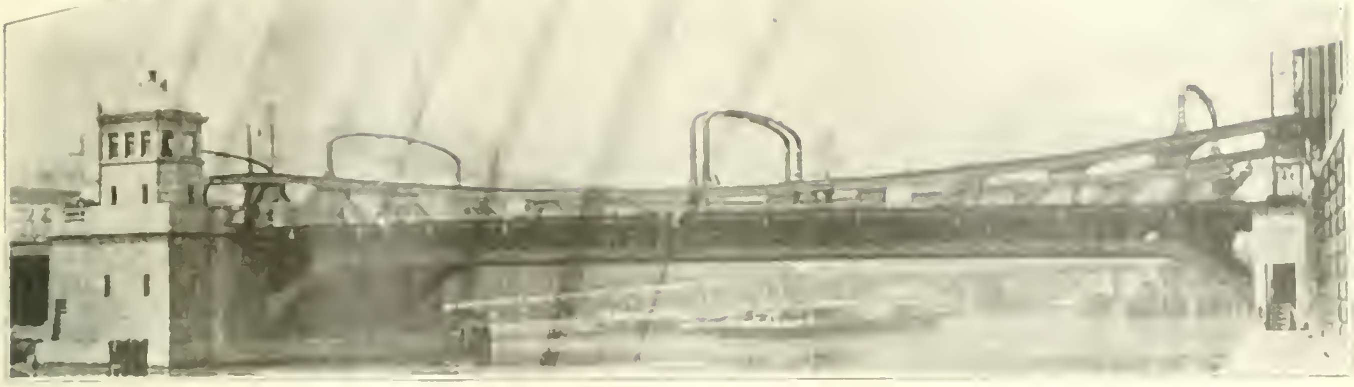
Built to Dig and Last While Digging

THE G. H. WILLIAMS CO. Erie, Pa.

WILLIAMS BUCKETS

Other bridges erected and under construction by the City of Chicago since 1913, involving Strauss patent, over the Chicago River, in addition to those illustrated, are located at Grand Avenue, Roosevelt Road, Washington, Wells Madison, Monroe and 92nd streets.

[illegible] District [illegible] Court of [illegible] Chicago.



Franklin Orleans Bridge

Strauss Patent Saved the City of Chicago $800,000 in Construction Cost on Ten Bridges

The last ten bridges contracted for by the city of Chicago since 1913 employed the Strauss patented support for the trunnions, which eliminates the use of columns or longitudinal girders in the space between the main trusses. The free space between the tail end of these trusses thus allows the use of inexpensive counterweight material.

The **Strauss** patented support of the trunnions further allows full angle of opening of the bascule leaf and is especially advantageous in the design of the component parts of the structure where the counterweight is integral with the trusses.

As compared with the standard trunnion bridge designed and built by the City of Chicago prior to 1913, the STRAUSS patent saved the City $800,000 in construction cost of the ten bridges erected since 1913.

The patent used in the Chicago bridges is only one of the many economical and efficient **Strauss** patents relating to movable bridges.

We can save money for anyone contemplating movable bridge construction whether for highway, railway or combined use.

Strauss Engineering Service, perfected through experience gained in 15 years' concentrated effort in design of over $30,000,000 worth of bridges in service, ensures correct and safe results for every type of structure.

Consult us before adopting plans or undertaking construction

North Leaf
Boulevard Link Bridge

THE STRAUSS BASCULE BRIDGE CO., ENGRS.
225 North Michigan Ave., Chicago, Ill.
New York Office, 30 Church St.
Canadian Office: 14 Windsor Hotel, Montreal
103 London Bldg., Vancouver, B. C.

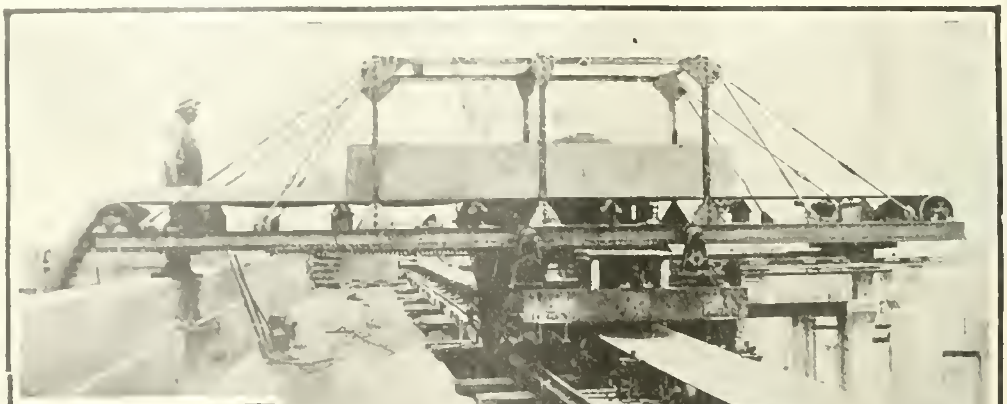
South Leaf
Boulevard Link Bridge

Lake Street Bridge

Elevating, Conveying and Power Transmitting Machinery

WELLER · MADE · CHICAGO

EQUIPMENT
FOR DURABILITY



Are You Prepared?

To take care of the big jobs ahead? Is your equipment ample to enable you to quote a price to compete with your competitors and make money on the job?

WELLER MADE EQUIPMENT

will help take care of the labor shortage and reduce the pay roll by doing the work mechanically that is usually done with day labor.

Weller made machinery never loafs on the job—it is specially designed, substantially built and will do the work that is required of it.

CALL ON US FOR

Belt Conveyors, Bucket Conveyors, Pan Conveyors, Drag Conveyors, Bucket Elevators, Car Unloaders, Car Loaders, Car Pullers, Power Shovels, Power Scrapers, Storage Bins, Screens, Weller Made Steel Chain, etc.

Catalogue No. 105E Will Interest the Engineer, Contractor and Road Builder. Sent on Request.

WELLER MFG. CO.
CHICAGO

NEW YORK
BOSTON

BALTIMORE
CLEVELAND

PITTSBURGH
SALT LAKE CITY

Railway Engineers Who Have Studied the Qualities of Lumber

are a unit in agreement on the fact that

CYPRESS "The Wood Eternal"

S C M A

TRADE MARK REG. U.S. PAT. OFFICE

(provided that you get Genuine "Tide-water" Cypress, guaranteed by the Association's Trademark)

is the best wood for all forms of use where high resistance to decay is an essential.

This fact is pretty clearly indicated by the recommendations of the Railway Signal Engineers Association for the use of cypress in

TRUNKING and CAPPING

It is equally valuable for *right-of-way fencing, snow fences,* and all similar forms of use where the material is constantly exposed to the action of the weather.

Make such forms of construction supremely durable by using

"TIDE WATER"
CYPRESS
"THE WOOD ETERNAL"

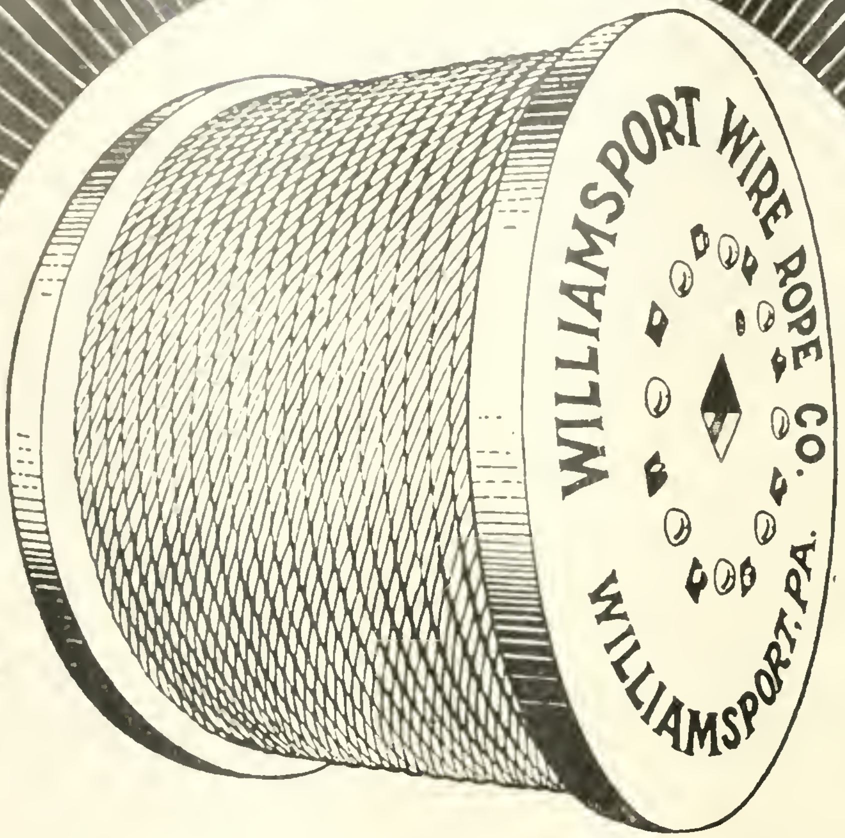
Full data regarding Cypress for all Railway uses will be furnished on request.

Southern Cypress Manufacturers' Association

Perdido Building
New Orleans, La.

1314 Heard National Bank Building
Jacksonville, Fla.

WILLIAMSPORT WIRE ROPE


WILLIAMSPORT WIRE ROPE CO.
WILLIAMSPORT, PA.

Has Strength and Toughness and Is Capable of Resisting Severe Abrasion

You can absolutely depend on WILLIAMSPORT WIRE ROPE. Every strand and every wire is tested before the rope is "closed in," and the resisting cable itself is also put to a final test before shipping.

WILLIAMSPORT WIRE ROPE is designed to give the proper service required in the particular place where it is to be used. It is made right, absolutely dependable, guaranteed.

WILLIAMSPORT QUALITY

Is the result of nearly forty years of manufacturing experience and growth. We are one of the largest manufacturers of wire rope in the world.

We have ample stock of WILLIAMSPORT WIRE ROPE, located in various cities, and we know we can satisfy you in point of service as in point of quality.

Try WILLIAMSPORT for that odd size

National Service—Quick shipments can be made from our warehouses below

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

New York, N. Y
Pittsburgh, Pa
Detroit, Mich
[illegible], Pa

Boston, Mass.
Denver, Colo.
Portland, Ore.
Houston, Texas

San Francisco, Calif
Cincinnati, Ohio
Tulsa, Oklahoma
Seattle, Washington

WILLIAMSPORT WIRE ROPE COMPANY
WILLIAMSPORT, PENNA.
Western Office, Peoples Gas Bldg., Chicago

—for Value that Endures Buy Smith Equipment

THREE prime factors determine whether or not your construction equipment represents a profitable investment — 1st — Performance; 2nd — Endurance; 3rd — Service.

Smith Equipment holds all records for speed in production and for endurance. Your investment is further safeguarded by an efficient service organization — representatives in all principal cities — equipped to *keep* Smith Equipment *producing*.

It is essential that you know about

SMITH TILTING MIXERS
Sizes 10-S, 14-S, 21-S, 28-S and 56-S Mixed Batch Capacities

SMITH NON-TILTING MIXERS
4-S, 7-S, 14-S, 21-S and 28-S Mixed Batch Capacities

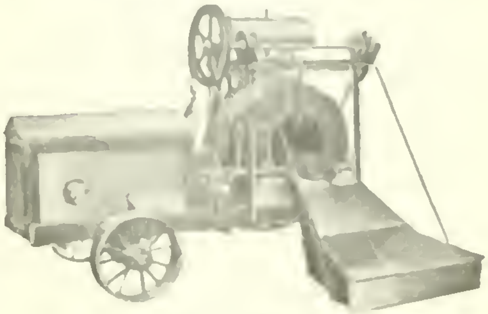
SMITH PAVING MIXERS
10-E, 14-E and 21-E Mixed Batch Capacities

SMITH EXCAVATOR & LOADER

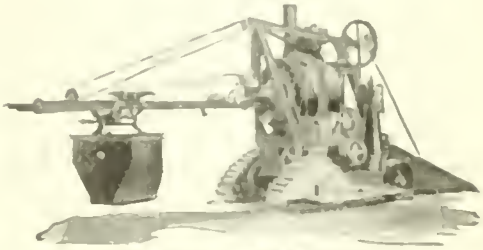
SMITH PUMPING OUTFITS

SMITH GLASS BATCH MIXERS

ENGINES, BOILERS, CONSTRUCTION EQUIPMENT



Smith 7-S Non-Tilting Mixer



Smith 21-E Paving Mixer

Write for Catalogs and Performance Records

Smith Equipment is in service all over the world. Twenty years of Export Experience and unequalled Export facilities assure the most pleasing foreign transactions in every detail.

Smith Outside Packed Plunger Pump

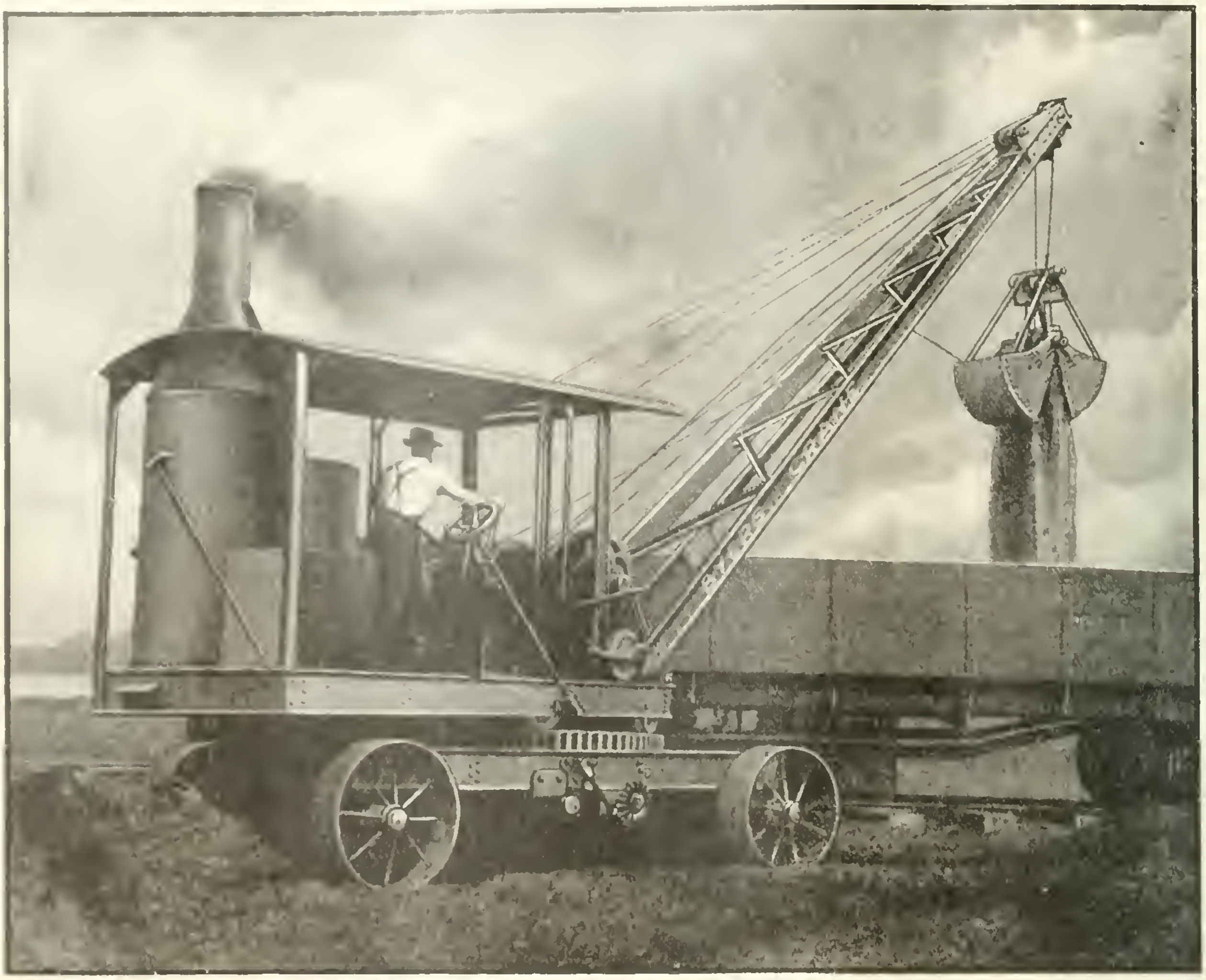
The T. L. Smith Company

351 Old Colony Bldg., Chicago, Ill.

Factories at Milwaukee, Wis.
Eastern Offices and Warehouse—50 Church St., New York, N. Y.
Western Warehouse—San Francisco, Cal.
Export Agents: — Richards & Hirschfield, Inc., 50 Church St., New York, N. Y.
Cable Address: Smithmixer, Milwaukee or Richirsch, New York

Smith Excavator and Loader

STANDARDIZE ON SMITH EQUIPMENT



A New Byers Crane—Full Revolving Type

THE John F. Byers Machine Company has brought out a full revolving crane. Its construction and design fully measure up to Byers' standards, established for 40 years. Purchasers may expect the same dependable service from this new machine that its partner—the half-circle swing "Auto-Crane"—is giving to more than 700 satisfied users.

Owners will find the new crane low in purchase and operating cost; sturdy and rugged, yet reasonably light in weight. It will be furnished mounted on broad-tire road wheels, crawling traction trucks under one or both ends, or standard-gauge rail trucks. When equipped for rail service, the machine will handle the work required of small locomotive cranes. Steam, gasoline or electrical power, at customer's option.

Full information gladly furnished. Write or wire
us direct or see the nearest Byers representative

THE JOHN F. BYERS MACHINE CO., 200 Sycamore St., Ravenna. Ohio

Sales Representatives in 25 Leading Cities

Showing a Rex 14-E Paver, with 20-foot Distributing Boom, laying concrete on city street

All Rex Pavers, and Rex Building Mixers Nos. 7-S, 14-S, 21-S, and 28-S, are chain driven with all-steel chain—Rex Chabelco Chain

465 Feet—7 Hours—and a Rex Paver

Mr. Pace, president of the Federal Paving Co., Chicago, tells us that in his twenty-five years' contracting experience he has never found a paver whose performance qualities approach those of the Rex.

On the twelve-mile Peoria-Henry Highway in Illinois, one of his three Rex Concrete Pavers—a 14-E—recently placed 465 feet of 8-inch roadway, 16 feet wide, in 7 hours' time.

The Rex mixed twice the volume turned out by another machine on the job, put down five of the six miles completed, and did not cause one minute's delay.

Coming from one of the largest and most successful contractors—a man who has worked virtually every make of paver and mixer—this endorsement of Rex Pavers carries an impressive significance. What the Rex Paver has done for the Federal Paving Company it can do for you.

REX PAVERS

AND MIXERS

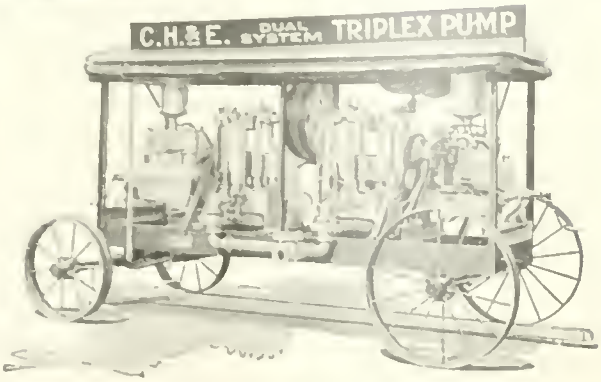
Rex Chains, Rex Traveling Water Screens
Rex Sprockets, Rex Elevators and Conveyors

CHAIN BELT COMPANY, MILWAUKEE

Branch Offices and Representatives in Principal Cities in the United States and Abroad

CH&E

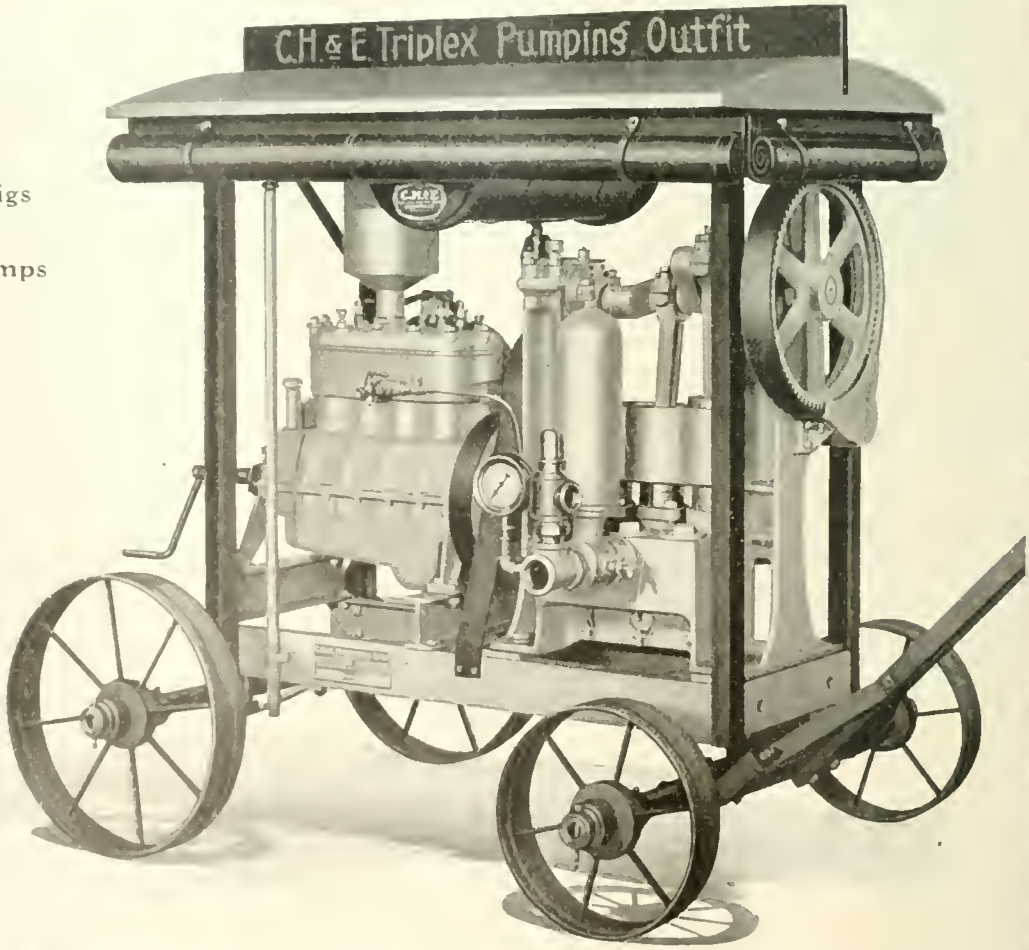
Road Pumps



CH&E Road Pumps, either single or dual pump mounting, are driven by four cylinder gasoline engines. The Dual Triplex Pump is a positive guarantee to the road builder that he will get water at all times. Our "Watering Down the Road" folder will be mailed on request.

We manufacture

- Portable Saw Rigs
- Bilge Pumps
- Centrifugal Pumps
- Piston Pumps
- Triplex Pumps
- Hoists
- Elevators
- Mortar Mixers
- Engines



Write for our catalog

C. H. & E. Manufacturing Company, Inc.

384-B Clinton Street

MILWAUKEE, WIS.

CH&E

Ingersoll-Rand

"Little Tugger" Hoists Are:

Light, compact, portable, compressed air or steam operated mine hoists. They can be set up anywhere almost instantly without the use of special tools or fittings.

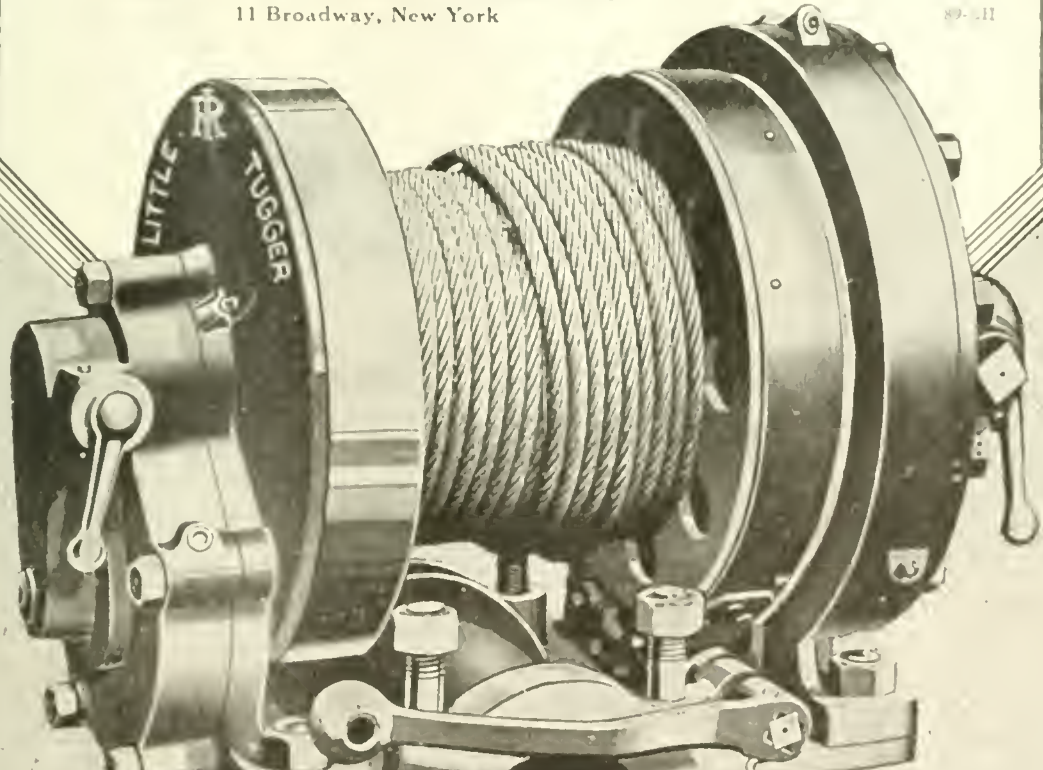
Weight without rope		*285 lbs*
Dimensions		*21¼″ x 16½″ x 20½″*
Hoisting capacity	*(80 lbs. air pres.)*	*1000 lbs.*
Hoisting speed	*(80 lbs. air pres.)*	*85 ft. per min.*

Can be clamped to a column or can be bolted to a timber.

Let us tell you how "Little Tuggers" will do your work.

Ingersoll-Rand Company
11 Broadway, New York

89-AH



300 sizes and types—all modern

EVERY air power user, no matter how large or how small his requirements, is able to secure a compressor best meeting his needs from the Chicago Pneumatic line, *most complete* because it consists of over 300 distinct types and sizes

EVERY Chicago Pneumatic, regardless of size or type, is of *modern* design and construction throughout—the last word in compressor manufacturing progress. The Simplate flat-disc indestructible valve is *one* C-P feature. Know *all* of them. Ask for Bulletins

Chicago Pneumatic Tool Company

Chicago Pneumatic Building • 6 East 44th Street • New York

*Sales and *Service Branches all over the World*

•Birmingham
•Boston
•Buffalo
•Chicago
•Cincinnati
•Cleveland
•Detroit
El Paso
Erie
Franklin
Houston
Joplin
•Los Angeles
•Minneapolis
•New Orleans
•New York
•Philadelphia
•Pittsburgh
•Portland
Richmond
Salt Lake City
•San Francisco
•Seattle
•St Louis
Barcelona
•Berlin
Bombay
Brussels
Buenos Aires
Cadiz
Christiania
•Fraserburgh
Havana
Honolulu
Johannesburg
Lisbon
•London
Madrid
Milan
•Montreal
Osaka
Paris
Seoul
Tokyo
Toronto
Vancouver
Winnipeg

C 83

BOYER PNEUMATIC HAMMERS··LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS··VACUUM PUMPS··PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS ·· COAL DRILLS

CHICAGO PNEUMATIC

Depend upon that Name

Annual New Equipment Issue

ENGINEERING *AND* CONTRACTING

Published by Engineering & Contracting Publishing Co., 608 South Dearborn St., Chicago.

HALBERT P. GILLETTE, *President and Editor* LEWIS S. LOUER, *Vice President and General Manager*
New York Office, Room 1503 Columbia Bank Bldg., 507 Fifth Ave., RICHARD E. BROWN, *Eastern Manager*
Cleveland Office, Room 413 Engineers Bldg., LEO EHLBERT, *Manager*

The four rotated special monthly issues and 4 quarterly issues of E. & C. (52 in all) entirely cover the civil engineering and contracting field at $4.00 a year. Any one of the four special monthly issues may be subscribed for as a monthly at $1.00 a year. The special quarterly issues relate entirely to foreign engineering and construction practice. The *articles* in the first two issues of each month completely cover the municipal engineering and contracting field. The *articles* in the first and fourth issues of each month completely cover county engineering and highway engineering and contracting. The *articles* in the 3rd and 4th issues of each month completely cover steam and electric railway location, design and construction. See the "masthead" on the first page of the Weekly News Section for information about our weekly contract news.

Roads and Streets—1st Wednesday
(a) Roads
(b) Streets
(c) Street Cleaning
(d) Municipal Miscellanies
(e) Management and Office System

Waterworks and Hydraulics—2nd Wednesday
(a) Waterworks
(b) Sewers and Sanitation
(c) Irrigation and Drainage
(d) Power and Pumping
(e) Management and Office System

Railways and Excavation—3rd Wednesday
(a) Excavation
(b) Management and Office System
(c) Quarries and Pits
(d) Steam Railway Construction and Maintenance
(e) Electric Railway Construction and Maintenance

Buildings and Structures—4th Wednesday
(a) Buildings
(b) Bridges
(c) Harbor Structures
(d) Miscellaneous Structures
(e) Properties of Materials
(f) Management and Office System

Copyright, 1920, by the Engineering and Contracting Publishing Company
Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

Extra postage in Canada, all issues $2.00; any one monthly issue 50c. Extra foreign postage all issues [illegible]; any one monthly issue $1.00.

Volume LIV CHICAGO, ILL., DECEMBER 29, 1920 Number 26.

Our New Equipment Issue

Three years ago ENGINEERING AND CONTRACTING began the practice of devoting one issue each year to descriptions of new construction and engineering equipment and material. The first of these issues appeared on January 30th, 1918; the second on January 29th, 1919. Last year we followed another policy and did not publish a new equipment issue.

Since then we have received so many letters asking that this particular feature be continued that we have decided to make the new equipment issue a permanent factor in our publication scheme. Accordingly, the present issue is given up entirely to descriptions of new, or improvements in old machinery and equipment and materials in the contracting and civil engineering field.

The issue forms a review of recent progress and therefore should prove not only full of suggestions to most of our readers, but may well be kept as a reference catalog of the latest engineering equipment.

Some of the things described in this issue have been described in our columns during the year, but to these have been added many other descriptions, so that the whole forms a comprehensive compendium of labor saving devices. The advertising pages also will be found instructive, covering as they do, a wide range of products of the latest designs.

In these pages—advertising as well as editorial—are brought together several hundred machines and products designed by the cleverest of engineers and inventors. America leads the world in the manufacture of machines for reducing the cost of construction. This fact, we believe, is impressively demonstrated in the pages of this issue.

The New Year—A Good Habit

A decidedly American and decidedly beneficial habit this, of starting each successive new born year with new resolutions. The same hopeful on-looking resolution indicates a salutary acknowledgment of past mistakes and an honest determination to eliminate them.

This particular ceremony is a well known establishment in the field of civil engineering and contracting. Not that we have been known especially for our faults. But when we do err—and who doesn't—we are not begrudging in the confession, nor slow in vigorous attempt to correct the error.

Accordingly, let us gather around the 1921 resolution table and proceed with the executive session on "Do's" and "Dont's."

First: What can be more appropriate as the first item of new (or is it old?) business than to renew our resolve, so painfully compelled by the war, to eliminate waste—waste of time, of materials, of labor, of all effort? Can we point to any need of the whole field that calls for attention before this?

Second: Shall we not subordinate selfish hopes for the exploitation of cross-roads inventions and personal propaganda to the common sense, sure development of the whole field we serve.

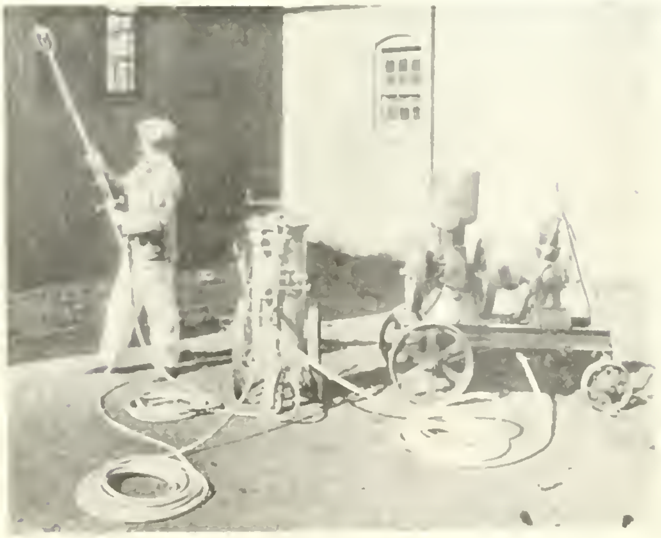
We're all making some private resolutions, too. But, back of each one, we feel sure, is a sincere wish for a very happy new year to be enjoyed by every civil engineer and every contractor, as we tear off the last page of the old calendar and look forward with strong hopes to an approaching season that holds more of real promise than any we have yet anticipated.

And, many happy returns of the same!

Recent Developments in Construction and Engineering Equipment

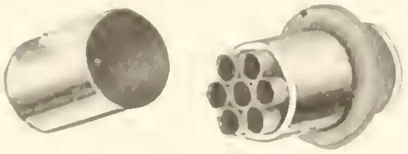
PAINT SPRAYING MACHINE.

A new paint-spraying machine for painting [illegible] structural work, concrete and masonry surfaces [illegible] general use of painting contractors has been placed on the market by the Vortex Manufacturing Co., Cleveland, O. An important feature of the machine is the nozzle. This has two openings—a central opening for paint and an annular opening around the center from which the air is discharged as a veritable blast under a pressure approximating 60 lb. to the square inch. There are separate conduits for air and paint, terminating in a right angle on each side, which forms an axis for the nozzle and permits it to be operated at any desired angle. The paint is driven from the central outlet under low velocity and is immediately picked up by the surrounding air jet and carried to the painted surface. The air jet is too powerful for the paint to penetrate. It works in defiance of wind and gravity and, while there is a small amount of spattering from the surface, this loss is remarkably small; and the whole tendency is to spread evenly, rather than to spatter. The manufacturers state that the machine has consistently maintained records of 2,000 sq. ft. per hour or more on plain interior work, where conditions were wholly favorable and the operator experienced in his task, and that it had been quite common for interior painting jobs, sometimes performed by novices, to be accomplished at the rate of 1,000 to 1,600 sq. ft. per hour. In a recent job at the E. 55th St. gymnasium in Cleveland, figures that had been preserved at that time and of the time spent in previous hand painting made a good basis for comparison. Panels 104 sq. ft. in size had been painted by 2 men at an average of 35 minutes per panel for a single coat. The Vortex appliance handled by 1 man did a panel every 5 minutes and the single application equaled 2 or perhaps 3 brush-applied coats in cover.


Assembly of Compressor, Paint Container, Air Pressure Applying Apparatus, Spraying Nozzle and Hose Connections, Etc.

BLASTING CAP CARRYING CASE.

The condition of the blasting cap is of vital importance, for upon it depends the degree of success of any blast. The charge in a blasting cap readily absorbs moisture, and its efficiency is decreased in direct proportion to the amount of moisture it has absorbed. The only sure way to get full execution from the explosives used is to keep blasting caps dry. The practice of carrying blasting caps loose in the pocket is dangerous. Nails, matches or some other article might enter the open end of the shell and cause an explosion by scraping the very sensitive explosive charge. Dirt, bits of paper, lint or tobacco might get down into the shell and block the spit of the fuse and a misfire results. A blasting cap carrying case which enables the miner to take proper care of his day's supply of caps, has been brought out by the Atlas Powder Co., Philadelphia, Pa. It is made of aluminum; is $\frac{7}{8}$ in. in diameter and $2\frac{1}{8}$ in. long, and holds seven No. 6 or No. 8 blasting caps. It has a telescope lid, which is protected by a rubber sleeve that covers the joint between the lid and the case, making it absolutely moisture proof.


Case for Carrying Blasting Caps.

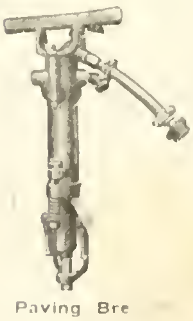
PORTABLE REPAIR SHOPS FOR MOTOR TRUCK FLEETS.

Moving repair shops, mounted on motor trucks, which were extensively used by the government during the war to care for its large fleets of trucks at home and abroad, may play an important part in facilitating the successful operation of the ever increasing fleets of trucks operated by large companies, contractors and road builders throughout the country. It is possible that with the increasing use of fleets of trucks in various lines of business the machine shop truck, as a flexible medium for keeping fleets of trucks in constant running order, at a minimum loss of time, will become as necessary and vital a factor for commercial use as it was during the war. The continuous operation of every truck is an important consideration with a fleet owner, and in this respect the machine shop truck has proved itself a time and money saver through its ability to go direct to the crippled truck and put it in shape at a minimum of time. The accompanying illustration shows one of these portable machine shops mounted on a Four-Wheel Drive Truck. On the chassis is complete equipment to handle any kind of repair job. A separate motor furnished the power for operating the various machine tools. This embraces such mechanical apparatus as a drill press, screw cutting lathe, electric grinder, blow torch, welding outfit, forge and more than 1,000 other pieces of machinery and tools. Each tool and piece of machinery has its own location, insuring compactness when the end and side panels are up and the truck is in motion.

Machine Shop Truck "Ready for Action."

PNEUMATIC TOOL FOR CUTTING PAVEMENT.

A new kind of machine known as a "Paving Breaker" has been recently brought out by the Ingersoll-Rand Co., New York. They are made in two types: one, weighing 58 lb., for air pressures of 80 lb. per square inch and over; and the other weighing 68 lb. for lower pressures. These machines are very similar to the company's standard line of non-rotating hand-hammer drills and have the same all-steel construction and essential features. Their field is the cutting and removing of asphalt, concrete and bitulithic pavements for pipe and conduit trenches, road repairing, laying tracks, etc. One company, using the heavier tool, with an Ingersoll-Rand Type 14 portable compressor, is stated to have reduced the cost of cutting and removing pavement to 33 per cent of the cost of old hand methods and completed the work in 25 per [illegible] time.


Paving Bre[illegible]

2-STORY SEPTIC TANK RESIDENTIAL SEWAGE DISPOSAL PLANT.

A vitrified salt glazed clay [illegible] for handling the sewage of residences and [illegible] has been brought out by Ferguson Segment Block Co., [illegible] Mo. The plant is composed of three principal parts: the settling chamber, the digestion chamber and the discharge chamber. Figure 1 is a general view of the [illegible] from the house enters the settling chamber through "A." The solid matter settles into the lower chamber (the digestion chamber), and the purified liquid flows out through "B." After six months' decomposition the sludge is pumped into the third chamber (the discharge chamber) through "C." Figure 2 is a view of a vertical section of the 2-story tank, with the connections of the inlet and the outlets. The essential feature of the plan is in the cone-shaped throat dividing the settling and digestion chambers. The settling solid matter passes down over the sides of the cone and is trapped in the digestion chamber. The gases from decomposition cannot force it up into the liquid, neither can the incoming flow of sewage stir it up. The sludge thus automatically is locked up and reduced to a state of inoffensiveness. The digestion chamber is designed to hold a year's accumulation. The gases that must escape pass through an opening at the top of the cone. Gravity only is the force that conducts the process, without the aid of any current breakers, baffle walls or syphon which require delicate adjustment. The only attention required by the system is in the extraction of the sludge. It is disposed of through "C" in a way that is shown in Fig. 3. Once about every six months the sludge is pumped into the discharge chamber by a simple plunger piston ("D"), with a valve, which operates in the extractor pipe ("C"). The digested sludge stands in the extractor pipe at water level and the pump is as simple to operate as a water hand-pump. [illegible] settles for a 6 months' treatment. The sludge conducted to the discharge chamber is left until it is thoroughly dry and entirely inoffensive, and then it is spaded out as so much earth. The system which is patented, is built in the following standard models:

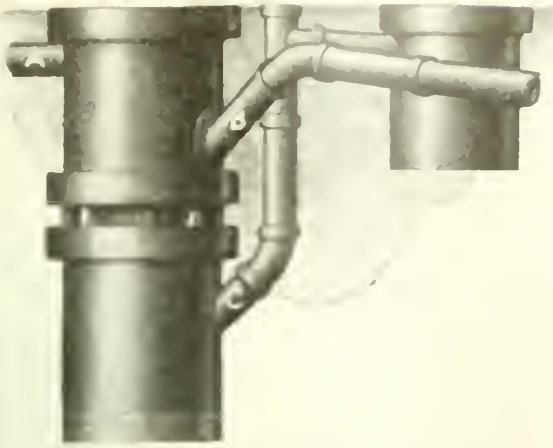


Fig. 1.—Elevation of System. 2-Story Tank at Left, Discharge Chamber on Right.

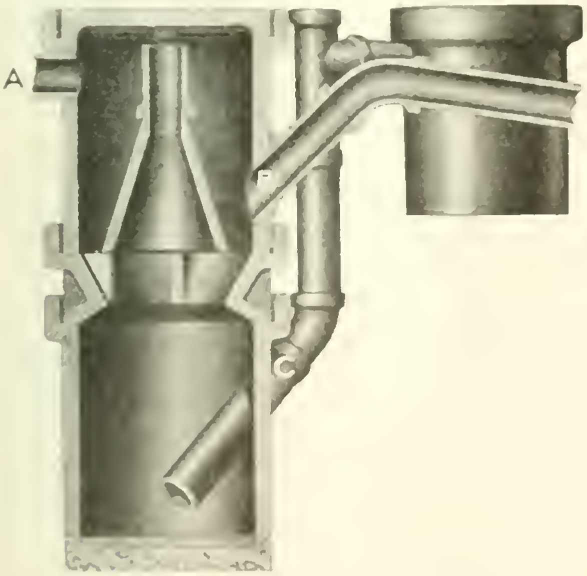


Fig. 2.—Vertical Section of 2-Story Tank

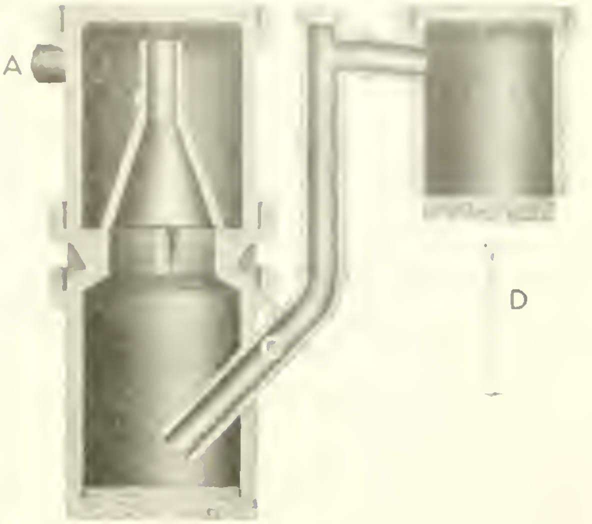


Fig. 3.—Vertical Section Showing Means for Semi Annual Extraction Sludge

INCLUDING DISCHARGE CHAMBER

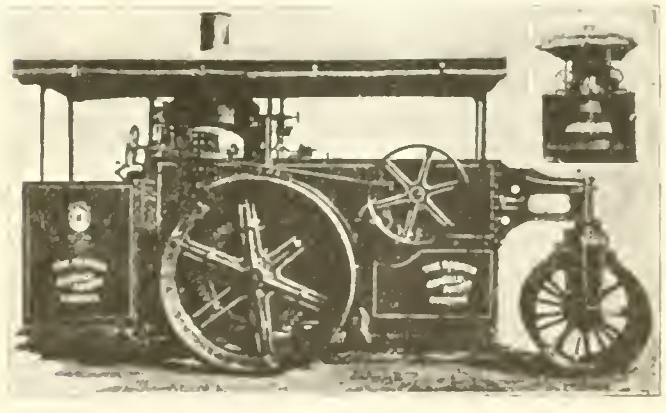
Model number	Number people	Size	Depth
245	1- 5	24 in	6 ft. 10 in
305	6-10	30 in	7 ft. 4 in
365	12-18	36 in	7 ft. 4 in
367	20-30	36 in	13 ft. 4 in

WITHOUT DISCHARGE CHAMBER

Model number	Number people	Size	Depth
244	1- 5	24 in	6 ft. 4 in
304	6-10	30 in	7 ft. 1 in
364	12-18	36 in	7 ft. 4 in.
366	20-30	36 in	13 ft. 4 in

NEW DESIGN OF MACADAM ROLLER.

After many years of experimental work and tests under actual working conditions the Iroquois Department of the Barber Asphalt Paving Co. has perfected and placed on the market what is claimed to be an entirely new type of macadam road roller. The most noticeable feature of the new Iroquois roller is the vertical boiler which rests upon the steel framework of the roller itself, a separate unit to which nothing is bolted. The boiler may be easily removed for repairs without disturbing any other part of the roller. It is stated to have over 50 per cent more heating surface than in the old type roller. The engine also is a separate unit and rests upon the roller framework, on a three point suspension that has demonstrated its many advantages in automobile construction. The drive is accomplished through a differential gear to the rear wheels. This may be locked out for hard



New Iroquois Macadam Roller.

straight pulls. Positive steer is assured through a steel quadrant that prohibits the front roll dragging and shoving up the surface of the highway. The rear wheels are equipped with demountable rims, easily renewed when worn. A steam scarifier is part of the standard equipment. It is adjustable, scarifying any depth desired the full width of the roller, in the hardest kind of material.

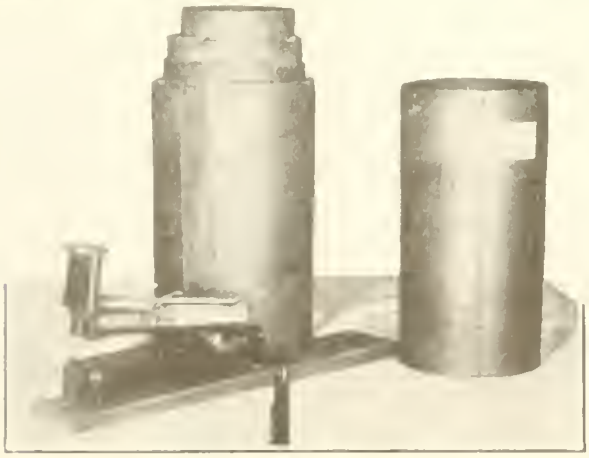
A NEW PLUG DRILL.

A new plug drill, for use in granite quarries, embodying features worthy of note, has been placed on the market by the Sullivan Machinery Co., Chicago. In general appearance, the new machine, which is classed as the "DH-3" drill, closely resembles the earlier Sullivan "DF-3" drill. Both tools are made throughout of the highest grade of alloy steel bars, and drop forgings, carefully machined with the working parts ground to exact size and to exceedingly close working fits. Before grinding, working surfaces are heat-treated by special processes to provide the necessary resistance to wear and breakage. The new machine weighs only 21 lb. It is 17½ in. in length and has a cylinder diameter of 1 7/16 in. The "DH-3" strikes a heavier and faster blow than the old drill, which gives it a considerably increased drilling speed and makes it particularly desirable for use in hard granite. On numerous test runs, the "DH-3" plugger has averaged holes 4 in. deep with ¾-in. plug bits in Barre granite in 15 seconds each. A new and essential improvement in this machine is the valve motion. The valve is situated in the rear end of the cylinder, and is entirely enclosed by the head block or housing of the machine. It is of the hollow or shell type and the valve action is in alignment with the motion of the piston. End seats prevent freezing and leakage. This valve is light, saves power and is not liable to breakage. Its action is not affected by wear. Air is admitted to the drill by means of a push handle throttle of the same type as that originally developed on the pioneer Sullivan plug drill and used since that time in improved form. The blow of the piston is hard and unimpeded, but a cushion is provided at the rear end of the throttle to avoid striking the back head, and at the same time to permit a rapid recovery and sharp forward strike or blow. In addition to increased drilling speed, the "DH-3" carries with it reduced vibration, making it easier for the operator to handle, and giving a high degree of air economy.

Sullivan Plug Drill Class "DH-3."

PAPER MOLDS FOR CONCRETE TEST CYLINDERS.

A paper mold that makes possible the testing of concrete on the job and provides a link between the field and the laboratory has been placed on the market by the Standard Concrete Apparatus Co., Washington, D. C. The molds are made of water proof paper and are slit so as to rest in little space. They make the standard compression test piece for concrete, a cylinder 6 in. in diameter by 12 in. length.


Models for Concrete Test Cylinders.

At right is assembled Cyl-O-Con mold with marking tag ready for use; at left is a bundle of ten nested molds; in center is the stapling machine used to assemble molds.

NEW TYPE OF MOTOR BUS.

A new type of motor bus put into service recently at Buffalo, N. Y., by the Pierce-Arrow Motor Car Co. is shown in the accompanying illustration. The bus is mounted on a Pierce-Arrow 2-ton dual valve chassis, equipped with pneumatic tires. The steel body is fitted with all the known safety devices and modern conveniences, including electric lights, push buttons, a heating system and window screens and shades. The driver and passengers have clear vision on all sides. The bus is stated to attain a speed of 23 miles an hour with ease, and to handle well in traffic. The bus has a capacity for 25 passengers.

New Motor Bus Recently Placed in Service at Buffalo, N. Y.

A NEW TRACTOR CRANE.

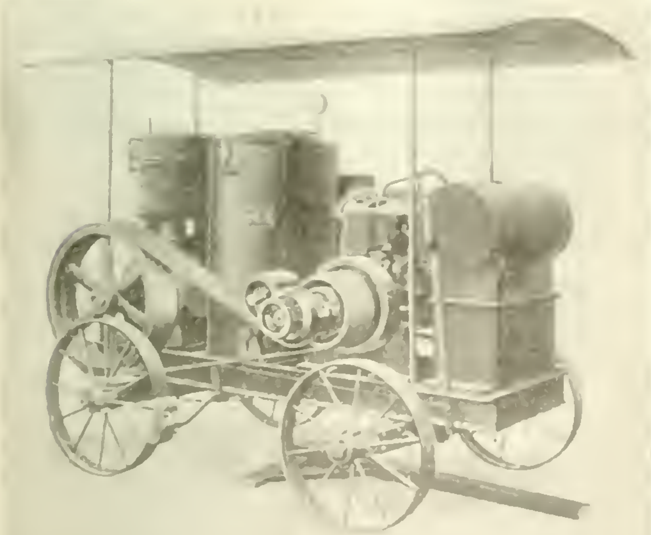
A tractor crane having several new features has been brought out by the Northwest Engineering Works, 28 E. Jackson Blvd., Chicago, Ill. It is claimed that this machine steers as easily as a tractor or motor truck, is at all times under the complete control of a single operator and is thus enabled to enter into distinct lines of work requiring quick action without maneuvering for position or special preparation. The motive and lifting power is furnished by a 60-hp. gasoline motor, mounted on a revolving platform, with a 30-ft. boom and traction unit made up of heavy duty caterpillar treads, operated with shifting gears to provide perfect

The Northwest Crawler Crane.

steerage. The caterpillar traction unit of the machine is so designed that by throwing a lever in the cab, the gear operating the traction on either side may be replaced with a smaller gear and the equipment enabled to make a complete turn in a minimum of time and without disturbing the pavement or material upon which it is running. It is claimed that in this machine the most inflexible features of [illegible] engine drive in dredging or hoisting are overcome through having the hoisting drums teamed with a brake drum with ratchet teeth, operating against a set of pawls. Thus with the engine operating at a set speed the load can be controlled and dumped at any given point with the same [illegible] steam engine efficiency. The balance of [illegible] traction have been stated to be so uniform that the [illegible] swing to any angle without the use of jacks [illegible] or stabilizing devices. The flexibility and utility [illegible] of the machine were recently demonstrated when [illegible] per cent grade to the top of a coal pile [illegible] back downward and forward [illegible] higher level as the coal pile expanded. [illegible] of the [illegible] of manganese steel. All [illegible] and are fitted with self-[illegible]. [illegible] steel, [illegible]

NEW PORTABLE COMPRESSOR OUTFIT.

A compact, portable [illegible] for the [illegible] of contractors [illegible] Chicago Pneumatic Tool Co., New York. The [illegible] end of the outfit consists of a two-cylinder single acting vertical air compressor having [illegible] diameter by [illegible] stroke, water cooled cylinders and plate valves. These valves have been designed for an operating speed of 100 r.p.m., and at this speed the capacity is 110 cu. ft. per minute. The compressor discharges directly into an air receiver having a volume of 10 cu. ft. The power end of the outfit consists of a vertical 4-cylinder gasoline engine having 1¾-in. diameter by 5-in. stroke water-jacketed cylinders. This engine operates at 1,[illegible] r.p.m. and is fitted with a friction clutch pulley of proper size to drive the compressor at its rated speed. The fuel consumption when operating at full load is 25 pints of gasoline per hour. Both engine and compressor are thoroughly cooled by a positive system of circulation. The cooling water is forced through the jackets and a high grade efficient radiator by two centrifugal circulating water pumps one driven by a belt from the compressor shaft, the other by gears from the engine shaft. A rapidly revolving fan operating directly behind the radiator draws through it a blast of cool air which extracts the heat. This system of cooling requires but little water and is simple and reliable in operation. The equipment is mounted firmly on an all-steel truck having a metal canopy top with canvas sides and ends. The front end of the [illegible] compartment and a single gasoline tank [illegible] enough to supply the engine with [illegible] at all times. A [illegible] hand brake is [illegible].



Chicago Pneumatic Portable Compressor.

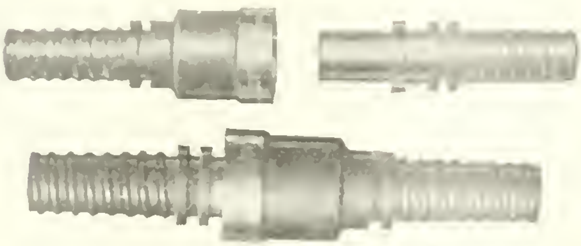
NEW OIL FORGE FOR DRILL STEEL.

The proper heating of [illegible] steel for forging and tempering purposes has [illegible] experience. In order to realize the [illegible] it is essential that it should be heated uniformly and without danger of burning and thus removing the carbon content, to just the exact heat experience has shown to be correct for each of these two purposes. The use of oil or gas furnaces has been growing in favor for several years past and this article describes a new oil or gas forge, which has been designed by the engineers of the Sullivan Machinery Co., Chicago, in conjunction with the builders of well-known equipment of this type, to secure the uniform results described above. The Sullivan drill steel furnace consists of a rectangular cast-iron box with fire brick lining, adjustable hearths and hoods, and having a burner or atomizer at one end as shown in the illustration. Steels may be inserted from either or both sides of the furnace, although in ordinary practice one side only is used and an adjustable stop made of fire brick forms an abutment for the ends of the steel. About 20 1½-in. bits may be placed in the furnace from one side at one time. Records kept over a long period indicate that the normal consumption of fuel oil in this furnace is from 16 to 18 gal. per day of eight hours, or approximately 2 gal. per hour. Compressed air is used for atomizing the oil fuel, being reduced from the high pressure service line to a pressure of from 1 to 7 lbs. as required by the character of the fuel. The furnace is 4 ft. 9 in. long, 2 ft. 9 in. wide and 4 ft. 2 in. in height over all. The combustion chamber is 15 in. long, 6¼ in. wide, and 7 in. deep. The furnace weighs 2700 lb. net.

Front View of Furnace Showing Steels in Position for Heating, and Signalling Pyrometer.

AIR HOSE COUPLINGS.

An air hose coupling with several new and important features has recently been placed on the market by the Ingersoll Rand Co., 11 Broadway, New York. It is called the "Little David" hose coupling and will be distributed as an accessory to the line of "Little David" pneumatic tools manufactured by the same company. Hose couplings which become leaky after short use are the cause of serious air losses, whether in the small shop or the large plant using hundreds of hose connections. Another trouble commonly experienced with many couplings is jamming or sticking through some slight injury, making them difficult or almost impossible to connect or disconnect. The design of the "Little David" coupling has been made with the view to overcoming these troubles. Its main features are its sturdiness and simplicity, and an [illegible] and ability to stand lots of [illegible] without affecting its [illegible]. Actual tests over long periods [illegible] have fully demonstrated its reliability. The coupling consists of two parts, male and female. The female end is fitted with a V-shaped rubber gasket providing an air tight seal. The gasket is prevented from blowing out should the coupling accidentally be disconnected under pressure by a [illegible] shoulder inside the coupling. The female end is exceptionally sturdy,

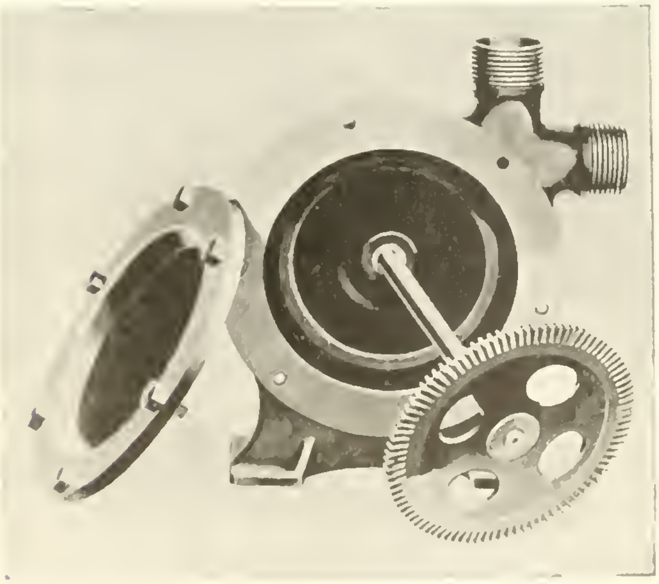

Little David Air Hose Coupling.

there being no exposed parts which might be liable to injury and cause jamming or sticking. The locking shoulders are heavy with large bearing surfaces. The locking spring is strong and durable, and can be replaced if necessary. The parts are made of a metal not subject to ordinary rusting or corrosion. The male end has a very liberal bearing in the female end which assures alignment and long wear. Another feature is the absence of any outer sleeve exposed to injury. The air ports are straight and of uniform diameter, offering least restriction to the air. The coupling may be connected or disconnected by a quarter turn. A groove in the hose end of each part allows using a hose clamp to attach securely to the hose. "Little David" hose couplings are manufactured in ½-in. and ¾-in. sizes, which are interchangeable; that is, a ½-in. male piece may be used with a ¾-in. female end or vice versa. Gaskets are also interchangeable between the different sizes.

PUMP HAS BUT ONE MOVING PART.

A distinctive type of pump containing but one moving part has been designed by the Western Pump Co., Davenport, Iowa.

A circular disc or impeller wheel, having a predetermined number of blades on each side of the outer rim, is attached to the revolving shaft. Pumping action draws the water in at the periphery instead of the center, as is the rule with centrifugal pumps, and discharges at the periphery under pressure. Sizes range up to 60,000 gal. per hour capacity, and

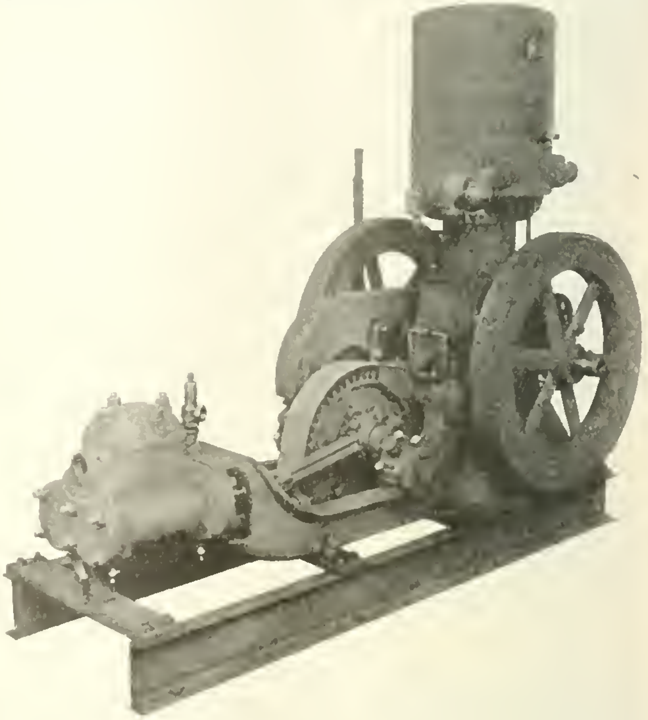

General Design of Pump.

it is claimed that the positive action of the plunger type, together with the volume and simplicity of the centrifugal, is obtained in practice.

Pressures are provided for up to 200 lb. to pump any type or kind of liquid. The general design is shown in the accompanying illustration.

PUMPING OUTFIT FOR ROAD BUILDERS.

A pumping outfit especially designed for pipe line pumping on concrete road work and for supplying water for drilling operations, has been brought out by the Novo Engine Co., Lansing, Mich. The outfit can be furnished in 6, 8, and 10 H.P. sizes and with capacities of from 28 to 50 gal. per minute, for operating against pressures up to 300 pounds or a 690-ft. head. The outfit consists of the standard Novo engine and a Novo back-geared pump both mounted on a channel steel base. The gears from the engine to the pump are cut gears. The pinion on the engine is mounted on a contracting-band friction clutch for disconnecting the pump when starting the engine. The pump gears are also cut gears and the pinion is cut from a solid steel blank. The large drive gear is bolted to a disc which is cast integral with the crank shaft of the pump and is mounted between the pump cranks. It will be noticed from the illustration that the pump frame has been extended to the base of the engine, thus making it possible to mount the engine at the end of the pump frame. In this type of duplex pump, with cranks set at 90 degrees, the pressure strokes overlap so that an almost continuous stream of water is supplied. This is very desirable when pumping long distances because it reduces the water hammer in the pipe lines and enables the outfit to pump the water longer distances with less strain on the pump.


Novo Duplex Pumping Outfit.

EIGHT-COUPLED SWITCHER FOR INDUSTRIAL SERVICE.

The motive power requirements of contractors and industrial plants are many and varied, necessitating the use of locomotives which differ widely in type and capacity. Among the most notable engines built for industrial service during the past year are two which were constructed for the Cambria Steel Co. by The Baldwin Locomotive Works. These locomotives are of the eight-coupled type, and are simple in construction with all parts of ample strength for severe service. The total wheel base of engine is 16 ft. and the locomotives operate on maximum grades of 1½ per cent combined with curves of 12 degrees, although they are capable of traversing curves as sharp as 24 degrees. These locomotives are notable because of their very high capacity as they exert a tractive force of 68,000 lb., which has not been exceeded thus far by any other eight-coupled non-articulated locomotive completed by the builders. The engines are used on rails weighing 85-100 lb. per yard. The boiler is equipped with a wide fire-box, and superheater, and has the unusual diameter for a switching locomotive of 86 in. The weight on driving wheels is 270,000 lb. Walschaerts valve motion is used and is controlled by a power-operated reverse. The cylinders are 27x30 in., and the driving wheels are 56 in. in diameter. The height and width of the locomotives are limited to conform to the Pennsylvania R. R. clearance diagram. The height is 14 ft. 8¾ in. and the width is 10 ft. 2 in. For this reason it was necessary to give careful attention to the location of the boiler mountings. The sand-boxes are four in number, placed two right and two left, and the bell is mounted at the front of the boiler on the left hand side. These locomotives are capable of handling about 2,000 tons at one end lading on a grade of 1 per cent and are suitable for the heaviest class of industrial switching service, where tracks are permanently laid and of substantial construction. Locomotives of similar type but preferably lighter in weight can also be used to advantage in heavy contracting service.

Heavy Industrial Type Switcher

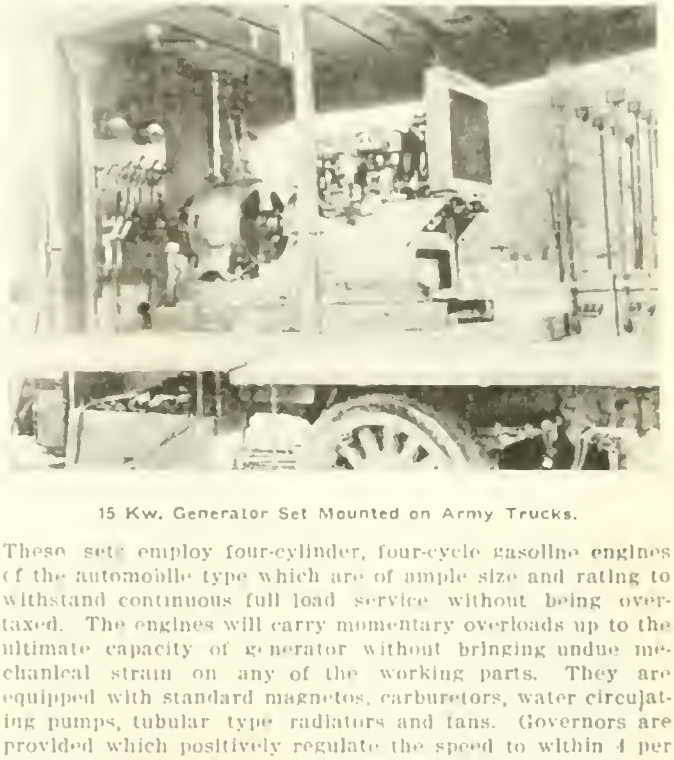
AUGER ROTATOR OF NEW DESIGN.

In drilling soft, broken or loose ground, it has been found that the ordinary compressed air hammer drill strikes too hard a blow for satisfactory progress. Its penetration is so great at each stroke that it is unable to throw the mud and cuttings from the hole, resulting in speedy clogging of the bit. To overcome this difficulty the so-called auger drill has been developed. In this type the stroke is relatively short and the blow light and rapid. At the same time, the strength and speed of rotation have been increased, to provide for keeping the hole true and round, and to aid in ejecting the sludge. Solid spiral steel and a "fishtail" bit are often used with auger drills, the twisted steel serving as a conveyor for the cuttings. An auger rotator brought out recently by the Sullivan Machinery Co., possesses certain distinctive features. This Sullivan "DR-37" auger rotator weighs 35½ lb. The strength and rapidity of rotation have been materially increased. In all the Sullivan Rotators the rotation is accomplished by means of straight and spiral flutes milled in the front portion of the piston bar, which are engaged by lugs on a removable bronze nut. The piston grooves also engage lugs on the interior of the encircling ratchet, which imparts the turning movement to the chuck, and thus to the steel, by the new model [illegible] carried by a four-[illegible] ratchet [illegible] the piston [illegible]. The action of the [illegible] rotator valve [illegible] with the [illegible] to keep [illegible] on the operator [illegible]. In this new model an automatic [illegible] has been embodied [illegible] the [illegible] parts [illegible] at all times. For [illegible] the "DR-37" is equipped [illegible] hollow steel [illegible] in the lower valve-buffer [illegible] air may be thrown down [illegible].

Sullivan Auger Rotator.

PORTABLE GENERATOR SETS FOR OPERATING CONSTRUCTION MACHINERY.

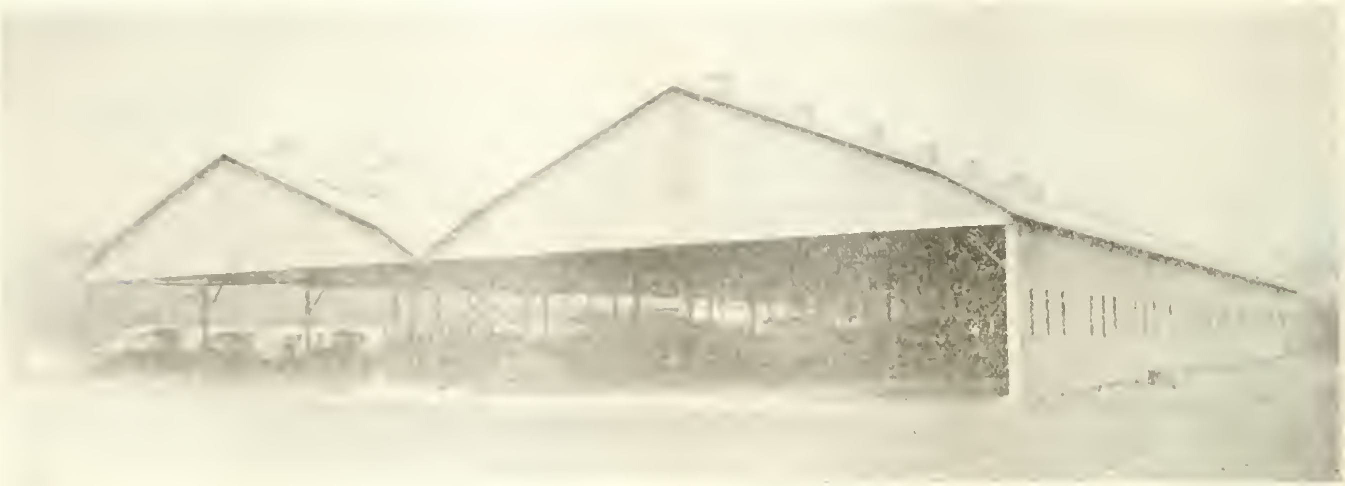
The requirements of the Army during the war brought particular emphasis to the fact that for certain work and conditions an independent portable source of power and light was indispensable. Gasoline engine-driven generators of various sizes were employed extensively to great advantage. The Allied [illegible] Mfg. Co., Milwaukee, Wis., which furnished a large number of these sets to the Government, has now placed them on the market for general use. They make available to the contractor a source of power and light flexible in application and comparatively cheap. Two sizes have been brought out: a 5 k.w., 110 or 220 volt and a 15 k.w., 110 or 220-volt. These sets employ four-cylinder, four-cycle gasoline engines of the automobile type which are of ample size and rating to withstand continuous full load service without being overtaxed. The engines will carry momentary overloads up to the ultimate capacity of generator without bringing undue mechanical strain on any of the working parts. They are equipped with standard magnetos, carburetors, water circulating pumps, tubular type radiators and fans. Governors are provided which positively regulate the speed to within 4 per cent of the set speed of the engine from no load to full load. The generators are provided with compound windings proportioned so that the voltage variations do not exceed 2 per cent from the set voltage from no load to full load. The 5 k.w. set has three main bearings; one being the standard ring oiled generator bearing, the other two being in the engine frame. The generator is held in accurate alignment by a rigid barrel housing which is machined to fit shoulders on the motor and generator frames. A coupling on the generator shaft fits into a recess in the flywheel and is bolted rigidly to it. The flywheel and coupling are enclosed in the barrel housing. This construction gives a very compact arrangement and one in which the bearing alignment does not depend upon the rigidity of the base casting and foundation. In this set the gasoline tank is mounted above the generator with gravity feed to the carburetor. The switchboard is mounted on angle irons attached to the base casting. The 15 k.w. set, which is shown mounted on an Army truck in the illustration, is in some respects different in construction from the 5 k.w. set. The generator is provided with front and rear bearing housings and is coupled to the engine by means of a flexible coupling. The gasoline tank is rectangular in form and is mounted in the base under the engine. The gasoline is raised to the carburetor by means of a vacuum system similar to that widely


15 Kw. Generator Set Mounted on Army Trucks.

used in automobile construction. In this set the switchboard is separately mounted and may be placed in any convenient position.

A STANDARDIZED SECTIONAL STEEL BUILDING.

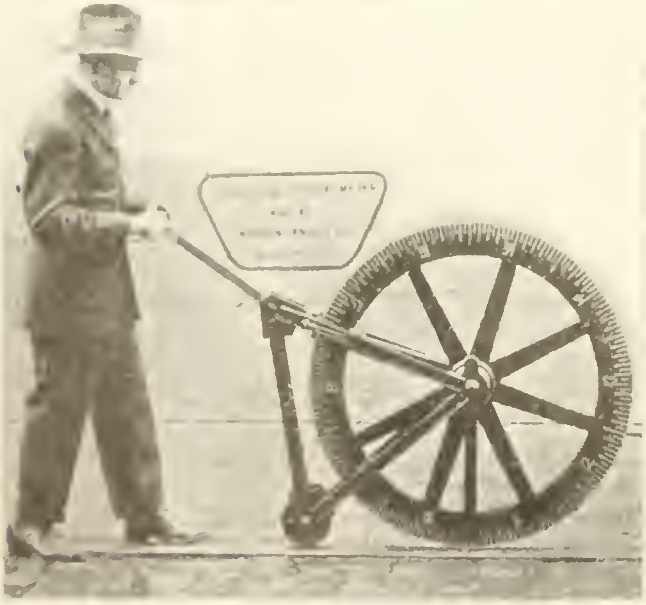
The Blaw-Knox Co. of Pittsburgh, Pa., placed on the market during the past year a sectional building. This building is made of steel throughout—a structural frame bolted together, specially pressed (patented) heavily galvanized sheet steel siding, steel doors, sliding or swinging windows and skylights may be placed wherever desired, being interchangeable with siding and roofing sheets. Standard ventilators and skylights are also furnished when specified. Prudential steel buildings—as they are called—are furnished in all widths from 8 ft. to 20 ft. and in any length. The same principle of design and manufacture has been applied to the Quixtet steel garage also placed on the market during the past year. They are furnished in single, double and multiplex sizes.



Standardized Sectional Steel Building.

NEW DEVICE FOR TRACK CHAINAGE.

A measuring instrument that is claimed to reduce track chainage costs 60 per cent has been placed on the market by the Warren-Knight Co., 136 N. 12th St., Philadelphia. This device, known as the "Sterling" Trackometer, requires one man to operate the instrument and one to make and record readings. It consists chiefly of a built-up hardwood measuring wheel with an adjustable brass tire having a true calibrated circumference of 10 ft., graduated in feet, tenths and half-tenths and numbered every foot. A strip of rubber inserted between the tire and wheel felloe furnishes the necessary resilience in adjusting the circumference, and roller bearings are used in mounting the wheel in its frame. The operating handle is hinged in the frame and may be held at any convenient height to suit the operator. The importance of the hinge feature lies in the fact that there being no fulcrum, it is impossible to raise the measuring wheel off the rail head by bearing down on the handle. A small cast-iron trailer wheel assists in guilding the instrument along the head of the rail. A direct reading counter mounted on the frame records in feet the distance traveled, the foot subdivisions being read off the measuring wheel. A positive hand brake enabling the measuring wheel to be locked securely in any position is allied with the indicator pointer. When necessary to remove the instrument from the track before measurement is completed, to permit car or other traffic movement, the brake is applied and a keel mark made on the rail at point of indicator. To continue measurement the instrument is replaced on the rail with the indicator at keel mark and brake released. The instrument can be used for track chainage, including tangent and special track work, for measuring paving yardage, and for land measurement where land is practically level.



Sterling" Trackometer.

NEW MODEL 15-TON RATCHET JACK.

A new model of 15-ton ratchet jack has recently been put on the market by the Duff Manufacturing Co., Pittsburgh. This jack, which is known as No. 339, while particularly adapted for bridge work, has a height and capacity suitable for general use by contractors. Easy operation is secured by the use of a large number of small teeth on the lifting rack. This fine-tooth rack decreases the amount of raise per lever stroke, but the effort required on the lever is reduced so greatly that more strokes can be taken in the same time. Hence the lift is very rapid. When in mesh with the rack, the pawls push straight up, doing away with side thrust and reducing wasteful friction between the rack and the rack channel. The lifting rack is of forged steel, heat-treated, with an exceptionally large rectangular cross-section to provide stiffness. Double-pointed pawls distribute the lifting pressure evenly between two of the rack teeth so that each tooth carries only one-half the load. The socket lever is a one-piece steel casting. The use of heavy fulcrum trunnions, cast integral with the socket lever, does away with the fulcrum pin hole which weakens the socket lever at a point subject to heavy strains. The jack is single-acting, raising the load on the down stroke of the operating lever. It has a height of 22 in. and a raise of 11½ in.

15-Ton Ratchet Jack.

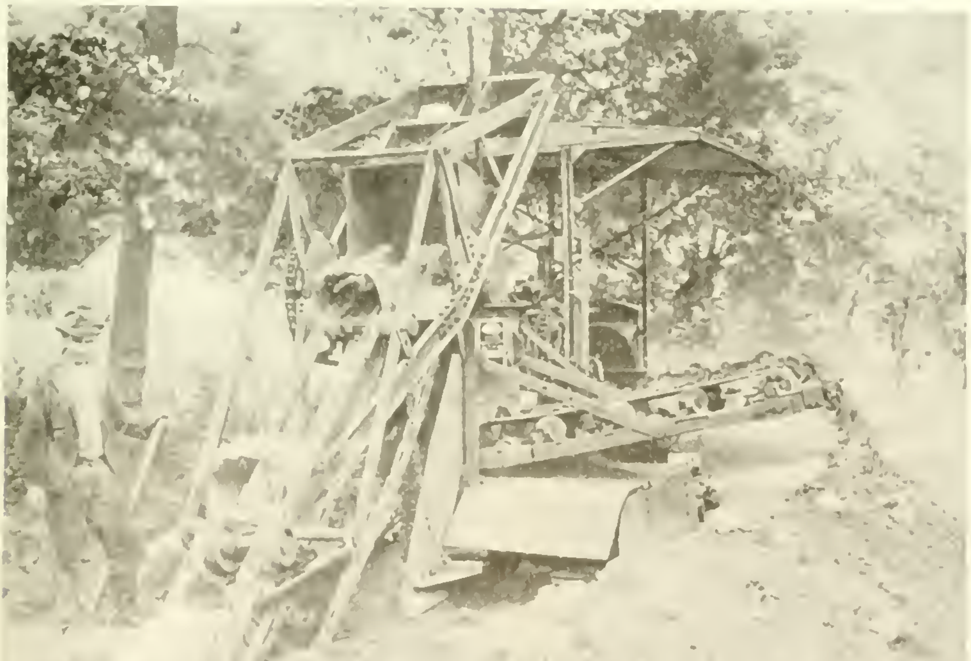
METER FOR MEASURING OIL AND GASOLINE.

Niagara Oil Meter.

A vertical dial meter with accuracy regulator, designed particularly for measuring gasoline or oil is illustrated. The vertical dial is 6 in. in diameter with black figures on white. On the small meters the large hand indicates pints, quarts and gallons from nought to ten gallons. On the large meters the hand indicates gallons from nought to one hundred. A knurled thumb piece projects through the dial glass so the hand may be turned back and automatically stopped at nought. A straight reading register which cannot be set back records the total gallons from one to one hundred thousand and repeats. The dial may be turned on the base of the meter to face any quarter. The meters are used to measure and compare the quantity of oil delivered in tank cars or otherwise with the amount invoiced; they are used to show the consumption and to regulate the flow of oil to burners under boilers, furnaces and ovens; they measure gasoline pumped or forced from gasoline storage and retailing systems. They will operate on pressures of a pound per square inch or higher, and on oil of any temperature, and thus are suitable for use under almost all conditions. These meters are made by the Buffalo Meter Co., Buffalo, N. Y.

A NEW ALL-MULTIPEDAL TRENCHING MACHINE.

The illustration shows the new all-multipedal Austin machine at work on trench excavation.



New All-Multipedal Austin Machine at Work on Trench Excavation.

This machine is designed to turn practically within its own radius, has full caterpillar traction and is a "one-man" trenching machine. The full multipedal traction steers through heavy friction clutches (one on each side) its action in this respect being similar to the military "tank." It is of sufficiently light weight to excavate trenches for house connections, sewers, etc. The machine will cross sidewalks, climb over a curb, cross lawns and travel over any type of pavement, thereby reducing to a minimum the danger of damage claims. It has an unusually high traction speed. A screw hoist raises and lowers the digging arm automatically, and the endless chain and buckets are of standard type. This screw hoist also acts in that way as a lever to force the buckets to dig, by crowding the bucket line against the face of the ditch or cut. A cleaning device takes care of the sticky dirt, and scrapes out each bucket as it passes a point at the head of the excavator boom directly above the conveyor belt. This can be adjusted to deliver the excavated material to either side of the machine. Attachments are provided for taking up slack in the belt. Strength and weight have not been sacrificed in order to secure a light speed, mobile and very sturdy digger. The gasoline engine is of 4 cylinder 4 cycle type, cooled by an enclosed radiator. Some of the details which are of interest to sewer, water, gas, electric and oil line contractors and corporations are as follows: The [illegible] width, with 18 in. buckets, [illegible] from 20 to [illegible] in., and with [illegible] in. buckets from [illegible] to [illegible]. The standard boom will dig up to [illegible] ft. in depth, although the machine is equipped for digging 8 ft. deep. The traction accommodates itself to irregular surfaces, as the equipment consists of two oscillating multipedals. Each one of these multipedal tractions is driven independently of the other by a friction clutch, so that in turning in a confined space, one may be stopped while the other is going ahead, turning the machine practically within its own length. The digging speed naturally depends upon conditions of the soil and the depth of trench. An important feature of the machine is its easy interchangeability for digging trenches with vertical banks or small ditches with sloping sides. This machine is made by the Austin Machinery Corp., Railway Exchange Bldg., Chicago, Ill.

A NEW TRACK SCALE.

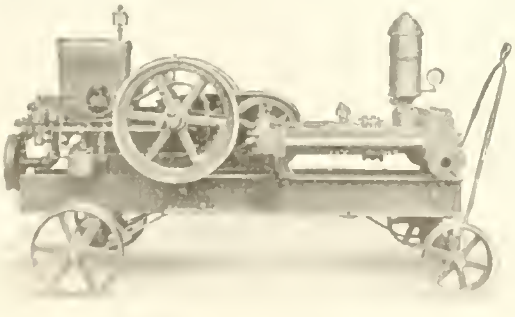
A new track scale embodying many new and exclusive features has been developed by E. & T. Fairbanks & Co., St. Johnsbury, Vt., manufacturers of the well known Fairbanks scales. An important feature of this scale is the departure from the use of the customary I-section levers, and the consistent use of the double web section throughout all levers of the scale. In this new scale the initial load is suspended from the center of the main lever bearing, and from that point is transmitted through the true center line of the lever to each succeeding bearing. The tip of one main lever of each pair is directly over or below the true center line of the opposite lever so that the combined pull of both levers is in one straight line to the center of the bearing which is on the center line of the longitudinal lever. The [illegible] the [illegible] longitudinal levers to the [illegible] with [illegible]. The scale is built on four [illegible] of [illegible] main levers transmitting the load to longitudinal

New Track Scale of Fairbanks & Co.

extension levers which in turn transmit the load to a transverse extension lever which connects through a shelf lever to the beam. It is built in two capacities for light duty service, or such service where only a relatively small number of cars are to be weighed. These two capacities are 60 tons and 75 tons per section and in lengths of 50 ft., 56 ft. and 60 ft. effective weighing rail. For heavy service or where a large number of cars are to be weighed the scale will be built in capacities of 75 tons and 100 tons per section, and in the same three lengths as above. The difference between the light duty and heavy duty scales is mainly in the loading per linear inch of knife edges, this being 5,000 lb. in the heavy duty scales and 6,000 lb. in the light duty scales. This difference in allowable loading and the allowance of a higher multiple main lever in the light duty scales serves to make somewhat lighter castings than are necessary in the heavy duty scales.

PORTABLE HIGH PRESSURE PUMPING OUTFIT FOR ROAD BUILDERS.

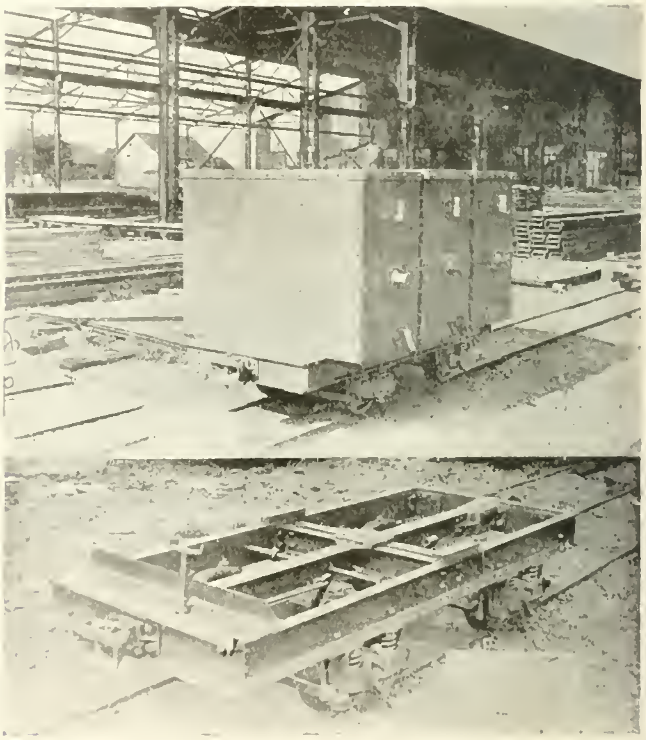
A high pressure, horizontal, triplex pumping unit, specially designed to meet the conditions met in road construction operations, was placed on the market by the Domestic Engine & Pump Co., Shippensburg, Pa. The units are built for hard and constant duty and for pressures up to and including 300 lb. per square inch. It is claimed that the outfit will handle water containing a small percentage of sand or grit without damage to the pump. The plungers do not come in contact with the [illegible] of the cylinders, being held in alignment by a very liberal cross head and working back and forth through stationary rings of waterproof hydraulic packing placed in easily accessible stuffing boxes. The pinion gear on the engine is engaged or disengaged by a friction clutch of liberal friction area. This permits the starting of engine without load and then when engine is up to speed the starting up of the pump gradually even against full load. The outfit is mounted on an all metal low-wheel, broad face tire truck, which makes unnecessary any other foundation for field installations. The unit is made in three sizes: 40 gal. capacity per minute and total work head of 500 ft.; 50 gal. capacity per minute and total work head of 380 ft.; and 50 gal. capacity per minute and total work head of 575 ft.



New Domestic Road Builders' Pumping Unit.

3-BOX CAR UNIT FOR DIRECT BATCH MIXER CHARGING SYSTEM.

A new car unit, for use in the direct batch charging system, that carries three buckets or boxes of either the tip-over or bottom dump type, of capacities up to 35 cu. ft. each of aggregate, and is still well within the limit of track and locomotive capacities, was placed on the market this year by the Easton Car & Construction Co., New York City. The car will carry two of the large 54 cu. ft. capacity batch buckets or boxes for the so-called 2-yard mixers or mixers of the 28-E class. It will carry two of the Easton Co.'s super-service batch buckets which are similar to the well-known contractors dump bucket which "pours" rather than dumps the material. The car is so arranged as to make it a very simple matter to attach to it a 1½-yd. capacity V-shape body of the rocker dump type for use in the preliminary stages of the job on cuts, fills, grading, etc., thus enabling the contractor to use his batch cars as dump cars. The under frame of the car is an extra heavy channel frame, thoroughly braced by gusset plates at all four corners and by center cross tie. The center sill is of I-Beam section. There is a steel plate, platform for brakeman at one end. The draft rigging consists of cast steel bull-nose bumper with link and pin coupling and double acting springs at both ends of the car, in a specially designed cast steel housing which acts as base or cap for the center sill. This housing keeps waste out of the draft rigging. The bumpers have extra wide faces and have cast steel guides and bumper plates which reinforce the ends till construction against wear and deformation. The brake is foot operated and very powerful, acting on all four wheels. The latter are extra heavy single plate type, made of best charcoal iron, well annealed with chilled treads, pressed on special steel axles. The journal boxes are of the roller bearing type, extra heavy, oil and dust-tight with oil reservoir and easily accessible oil inlets. These boxes operate in double spring pedestals, made of cast steel of special design which are tied together across the car to prevent any possibility of spreading from end thrust on the curves.



New Easton 3-Box Car Unit.

IMPROVEMENTS IN BUCKET LOADERS AND CONVEYORS.

During the past year self-oiling carriers have been made a part of the equipment of the conveyors made by the Barber-Greene Co., Aurora, Ill. and a new construction of intermediate sections has been adopted which makes it possible to ship them knocked down. On the Barber-Greene bucket loader, the crawler type of traction has been adopted as standard. The use of crawlers makes it possible to turn the machine around in its own length as one crawler can be stopped while all the power is diverted to the other to furnish the turning force. In addition the crawlers permit the machine to be operated on soft ground. The crawler traction consists of continuous treads 58 in. long by 8 in. wide which make a bearing pressure on the ground of only 7 lb. per square inch. A somewhat radical departure from the general Barber-Greene design of standardized conveyors has been made in the new universal conveyor recently put on the market. Type "U" instead of having trussed sectional construction has a channel frame 4 in. by 22 ft. Twenty-two feet has been adopted as the only length since this machine is designed only for unloading cars and loading wagons on trucks and other jobs where length and height of discharge are not needed. This is called "the conveyor with the digging end" because of the new method of belt and hopper construction. The lower end of the machine is built with belt exposed. Cupped blights across the belt furnish the digging effect, so that the machine may be pushed into a pile of loose material where it will burrow its way under as long as the pushing is kept up. The standard belt width is 12 in and every inch is made available by overlapping steel side plates attached on the edges of the belt. They form a trough as wide as the belt, and prevent any wear on the belt edges. Skirt boards the full length of the machine set at an angle make it possible to carry lumps much larger than 12 in.

Barber-Greene Bucket Loader and Conveyor

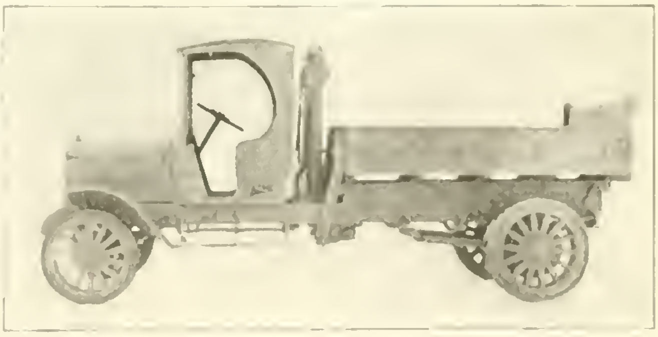
MECHANICAL BALLAST CLEANER.

Every railway maintenance engineer knows how essential it is to have rock ballast clean, especially in the winter months, as the dirt pockets accumulated during the summer freeze at that time, causing an uneven pressure on the rails. Water collects in dirty ballast in every season of the year, and causes the short-circuiting of block signals. Ballast cleaning has always been a difficult problem to the railroads using rock ballast, and there never has been a time when abundant labor could be found to do the work entirely by hand. With the acute labor shortage prevailing for the last three years, it has been almost impossible to find enough men to do the work at a wage which the railroads could afford to pay. A number of eastern railroads, including the Pennsylvania, the Baltimore & Ohio, the New York, New Haven & Hartford, the Western Maryland and the Central of New Jersey, have now adopted the mechanical ballast cleaner shown in the illustration. An outstanding feature of this labor-saving device is that when operating in the ditch between tracks it does not have to be moved for passing trains and clears all traffic safely. A compact gasoline engine mounted on the mechanism operates the machine. The early ballast cleaner now in use advances on caterpillar travelers which rest on the ends of the ties in the intertrack space, and is moved by a hand ratchet at the rear. In future machines, this ratchet will be harnessed to the engine, and the cleaner will go forward under its own power. In operation the rock ballast is taken up by a bucket scoop, elevated and dumped into a shaking screen. The dirt goes through a tray beneath, to be shoveled off by hand, while the clean rock passes over the screen and is deposited in the ditch again. The cleaner is stated to maintain a speed of one standard rail length of 33 ft. in 15 minutes. It is claimed that the machine, with five men, one of whom acts as a watchman, does the work of 10 men in less time, more efficiently and at a greatly reduced cost. In the near future the manufacturers expect to further develop the device so that one of these workmen can be eliminated, and the machine with four men will do the work of 10 men safely even when operating on double-track systems. This ballast cleaner is manufactured by the Link-Belt Co., Chicago. It was invented by Mr. H. D. Pratt, a mechanical engineer of the company. In connection with the standard rock cleaner, an auxiliary machine is being developed by the Link-Belt Co., the purpose of which is to keep the ballast free of dust and cinders after it has been treated by the cleaner. This device will be mounted on a standard gage truck, and a suction mechanism will be operated by a large fan on much the same principle as the vacuum cleaner. The suction cleaner will take up loose particles of dirt to a depth of 6 in. below the surface of the rock ballast.

Link-Belt Ballast Cleaner in Operation on Main Line of Pennsylvania R. R.

COMBINATION DUMP AND STAKE TRUCK BODY.

A truck body specially designed to combine the advantages of an all steel dump body with those of a stake body was brought out by the Acme Motor Truck Co., Cadillac, Mich. The dump body sides, and the stationary battlements which support the lifting arms, are constructed of extra heavy rolled steel, reinforced with angles. The battlements, 24 in high and 30 in. long, unite with the dump body sides in forming an inside body compartment that can be dumped absolutely clean in 20 seconds. When not in use as a dump body, the steel sides and steel tail gate are instantly removable, side stake racks 36 in. high, which are furnished as regular equip-



Truck Body with Interchangeable Dump and Stake Body Sides.

ment substituted in their place, and a steel [illegible] tail gate which hinges on bottom placed in position. An [illegible] and 21 in. wood reinforced tail gate when lowered extends platform length to a practical 10, 12 and 14 ft. [illegible] in the 2, 3½, and 5 ton trucks, respectively.

FACTORY MADE LEAD JOINTS FOR CAST IRON PIPE.

A factory made prepared joint for bell and spigot cast iron pipe has been developed by the research department of the American Cast Iron Pipe Co. The joints are made at the foundry and shipped to the job as an integral part of the pipe. An account of how these joints are made follows: The finished pipe come down the pipe runs. Six pipe at a time are rolled onto a tilting platform and thus are [illegible] into a vertical position with the bell end up. When these pipe stand on end the bells are about 2½ ft. above an overhead platform. Here stand two expert joint makers with the necessary equipment, whose first move is to insert a short mandrel into each of the six vertical bells. The bell on which this joint is furnished is the ordinary socket as to depth, diameter and other essential dimensions. The slight difference is that the bottom or shoulder of the bell is beveled off on a 30-degree angle as shown in Fig. 1, instead of being square. The lead groove, also, has been made with a sharper shoulder so that the calking is much more positive. A band of iron wedges held together by a strip of lead is first inserted around the mandrel. Two layers of square hemp, especially braided for this purpose are next inserted and calked on top of the wedges. Then hot lead is poured into the joint and the mandrel extracted, leaving all the joint materials in place. A concrete plug, shown in Fig. 2, is inserted to protect the joint materials in shipment, and the pipe and joint are ready for the trench. This concrete plug is so designed that it may easily be broken out or jerked out of the bell by means of any convenient bent rod or the bent end of a pinch bar or crow bar on the job. One can thus actually look into the bell and see the condition of the joint materials before they are calked. This, of course cannot be done with the ordinary joint, and is very important. Having the joint all right so far, the trench crew now inserts the spigot of the next pipe, which is so marked as to show when it is fully seated in the bell. The spigot is inserted easily because the mandrel over which the joint was made at the foundry is slightly larger in diameter than the spigot end of the pipe. All pipe with this joint are made without a bead on the spigot end. After inserting the joint "home" in the bell, the calker now simply takes his usual tools and calks the joints in the same way as he would the ordinary joint. With this joint, however, the lead is driven farther back and the force of the hammer blows penetrate to the hemp, which is thoroughly calked as well as the lead. Thus a better and tighter calking is possible. The joiut is designed to fulfill certain definite purpose after it is made. The inside shoulder of the bell, which has been referred to, Fig. 2, engages the iron wedges so that with the slightest deflection of a joint, these wedges are forced along the inclined shoulder and at the same time backward against the hemp and lead. Thus further compression, exerted internally, automatically tightens the joint as deflection takes place.

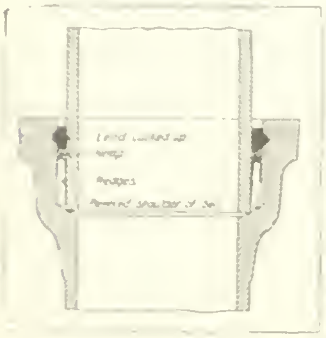


Fig. 1—Cross Section of Partly Completed Joint.

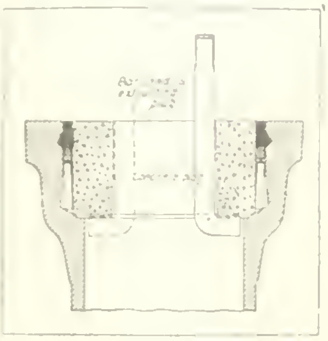


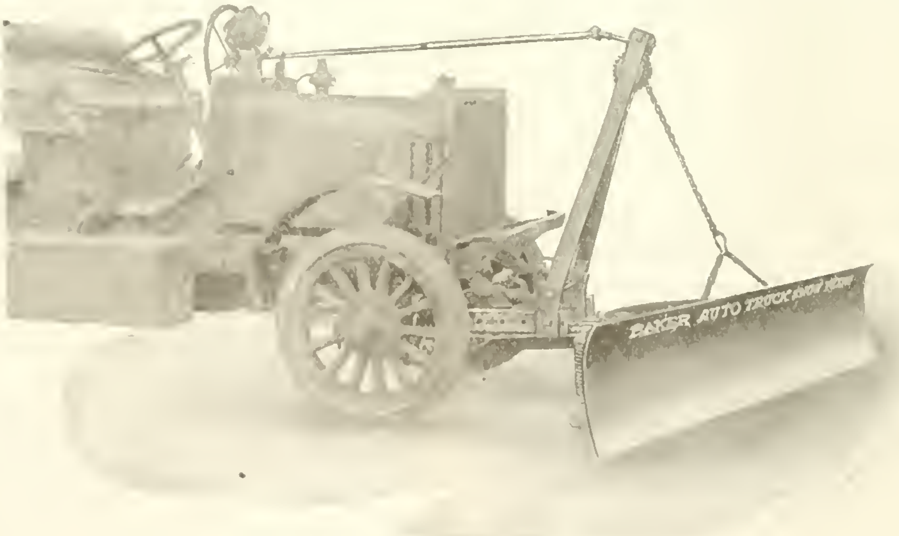
Fig. 2—Method of Removing Concrete Plug.

SELF PROPELLED POLE HOLE BORING MACHINE.

A combination of tractor and earth boring machine, which it is claimed digs a hole and sets up a telegraph pole in about 8 minutes has been brought out by the International Earth Boring Machine Co., Chicago. The earth-boring machine is mounted on the frame of a tractor. When the spqot at which the telegraph pole is to be erected is reached, the power from the tractor engine is switched to the earth-boring machine. This is an auger which will bore a hole in the ground any size from 2 in. to 30 in. diameter, and as deep as 8 ft. When the hole is bored the steel tower in which the auger is contained is then used as a crane to lift the telegraph pole and set it in position. The machine is made by the International Earth Boring Machine Co., Chicago.

MOTOR TRUCK SNOW PLOW.

A snow plow developed during the current year that is claimed to be a practically universal attachment to standard trucks for snow-moving on highways and streets is illustrated. One of the special features of this plow is the method of clamping to the front axle which allows for attachment to the axle only without drilling of holes. Another feature is the swinging of the blade at the bottom of the moldboard, which is supported by strong springs, which allow the blade to swing back quickly, after passing an obstruction. This prevents the spilling of snow to any extent back of the plow after passing such an obstruction. The plow is equipped with worm lift with chain winding over a spool. This permits lifting the plow vertically when not in use, or in turning around. The plow is made in 8 and 10-ft. lengths for use with various types of motor trucks, and can be attached to such trucks in a short time. The clamps are constructed, so that they can be attached to the truck at all times—whether the plow is used for snow-moving or not. The plow can also be used in front of the truck for smoothing up dirt roads. The plow is made by the Baker Manufacturing Co., Springfield, Ill.

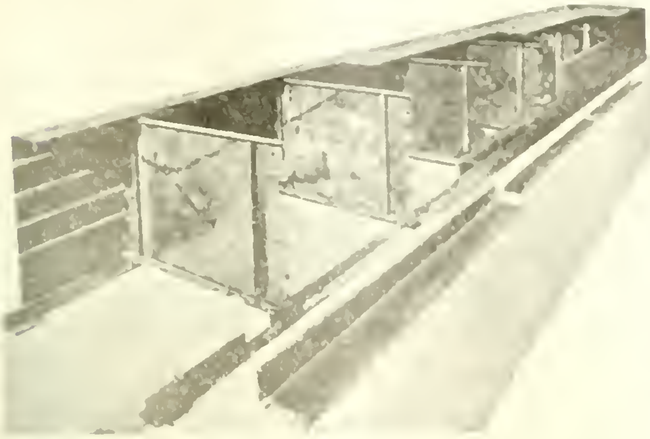


Baker Motor Truck Snow Plow.

A NEW FLAT-TOP CULVERT FORM.

A flat top collapsible, adjustable, oneman culvert form, designed by H. E. Bilger, formerly road engineer of the Illinois State Highway Department, has been placed on the market. The forms consist essentially of only three parts, namely, base angles, centers and cover plates.

The base angles are 9 ft. long [illegible] in. thick

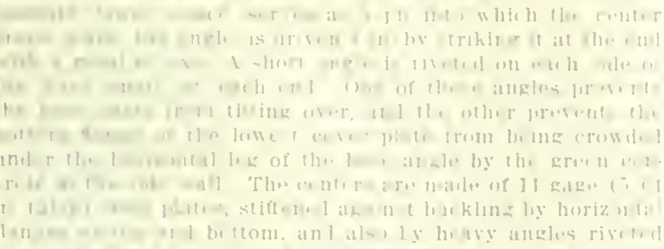


[illegible] ft. Lengths of [illegible] Culvert Form[illegible]

and are of [illegible] symmetrical and interchangeable throughout [illegible] forms [illegible] of nothing [illegible] vertical [illegible] large angle [illegible] in the picture [illegible] used and [illegible] at $\frac{1}{4}$-in. [illegible] plates that constitute the [illegible] which the [illegible]. These levels [illegible] 20 in. apart in the [illegible] in. as shown in the picture, and this [illegible] serves as a [illegible] into which the center [illegible] angle is driven [illegible] by striking it at the end with a [illegible]. A short angle is riveted on each side of the [illegible] at each end. One of these angles prevents the base angle from tilting over, and the other prevents the bottom [illegible] of the lower cover plate from being crowded under the horizontal leg of the base angle by the green concrete in the side wall. The centers are made of 11 gage ([illegible] in. thick) steel plates, stiffened against buckling by horizontal flanges at top and bottom, and also by heavy angles riveted vertically onto the main plate. All cover plates are 9 ft. long and are made of 11 gage hot-rolled blue annealed steel. The corner pieces are [illegible] in. vertically by 9 in. horizontally, all one piece.

A NEW BAR SPACER.

A new bar spacer for reinforcing steel for concrete slabs has been brought out by the Universal Form Clamp Co., 1[illegible] N. May St., Chicago, Ill. Its use is claimed to assure the architect and contractor: That the bars in the slabs are all supported the proper distance from the forms, that the bars when placed are spaced as called for by the plans, and that when so placed, the steel cannot be dislodged. The supporting device consists of four laps of metal, the middle



Universal Bar Spacer

loop being directly under the load prevents any wedging action by the bar. The tie is 16-gage annealed wire. These spacers are detailed directly from the plans, to contain the number of bar positions and the spacing called for. They are made in three heights: to support the steel, ½ in., ¾ in. and 1 in. above the forms.

A NEW EXCAVATOR.

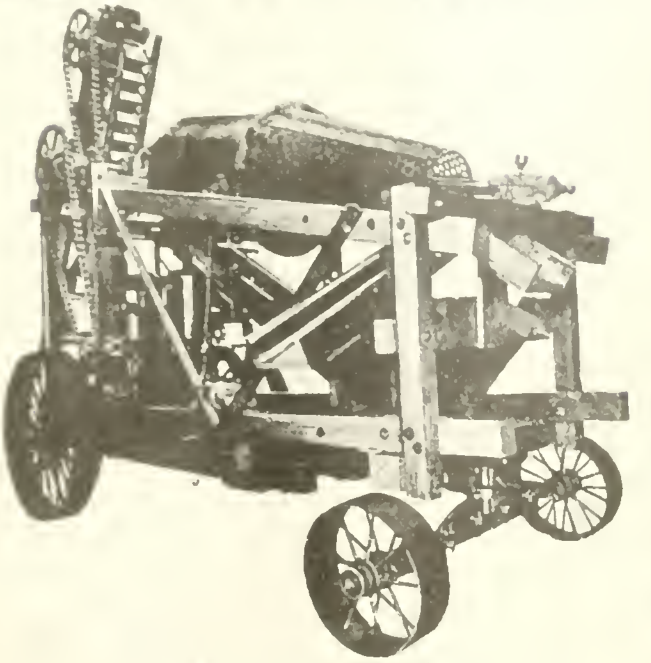
An excavator, having some unusual and interesting features, is illustrated. A [illegible] tractor mounted upon the rear end of the machine [illegible] as motive power and by means of chains and gears the power is transmitted to the four operations of the excavator, consisting of digging, hoisting, rotating and traveling. The [illegible] operating machinery is carried on a steel frame the front part of which is mounted on a [illegible] the rear part supported [illegible] pivoted in [illegible] and connected to [illegible] by means of a ball [illegible]. The [illegible] the latter [illegible] [illegible] The conveyor [illegible] the [illegible] speed [illegible] ft. per second. The [illegible] higher speed, and by friction [illegible] for the lower speed, the latter being made reversible by [illegible] friction clutches. The machine is steered by swinging the end axle, or by throwing one or the other of the treads out of gear. That part of the equipment is of standard manufacture. In a test the machine while operating against a [illegible] bank is stated to have excavated and delivered dirt to

The Watts Excavator.

the conveyors and discharged it on the side at the rate of 90 cu. ft. per minute. The buckets excavate in continuous chain, without lost motion, and the impact of each bucket is comparatively light. Figures taken from the specifications are as follows: Bucket capacity, theoretical 1 cu. ft. Bucket speed, 150 ft. per minute, bucket spacing, 12 in. Theoretical capacity of elevator, 150 cu. ft. per minute. Weight of machine, 32,000 lb.; length of frame, 20 ft., length of machine over all, 36 ft., width over tread, 9 ft. Maximum width of cut, 21 ft. Gasoline consumption, 5 gal. per hr. A point claimed for the excavator is its adaptability to operating economically in making shallow as well as deep cuts. This machine is manufactured in Portland, Ore., by the Watts Excavator Co., of which Thomas A. Sweeney is president.

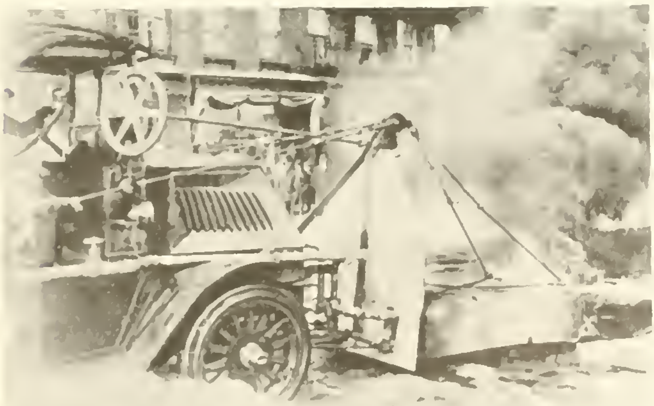
SMALL PORTABLE GRAVEL WASHING PLANT.

A small portable gravel washing machine has been developed by the Link-Belt Co., Chicago, not to replace the large permanent plants, but to fill a demand for a small machine which could be moved from bank to bank on road work and contracts where permanent plants are not available and the gravel must be taken from small deposits. The machine consists of an elevator, preliminary scrubber, screen and sand dewatering device—all mounted on heavy wheels with broad tires. The elevator is made with heavy steel buckets mounted on single strand chain. The elevator frame is so constructed that it can be folded up when the machine is to to hopper. A small hand winch is provided to [illegible] the elevator when it is to be folded or unfolded. The [illegible] and screen are of the Dull patented type consisting of a cylinder mounted on the same shaft as the screen and geared into ten compartments and having lifting vanes or paddles on the inner circumference of the shell. These are so arranged that the material is thoroughly agitated and [illegible] before it enters the screen. The screen is arranged to divide the material into one grade of sand, one grade of gravel and remove the oversize. The sand and water after passing through the screen drops into a settling tank. The dirty water overflows at the end of the tank and the sand is dewatered by means of a heavy screw conveyor. The plant is driven by a gasoline engine mounted on the same frame and connected by the necessary gears and drive chain. The machine washes and screens material thoroughly and is stated to have a normal capacity of about 10 cu. yd. per hour of pit run material.


Portable Gravel Washing Plant.

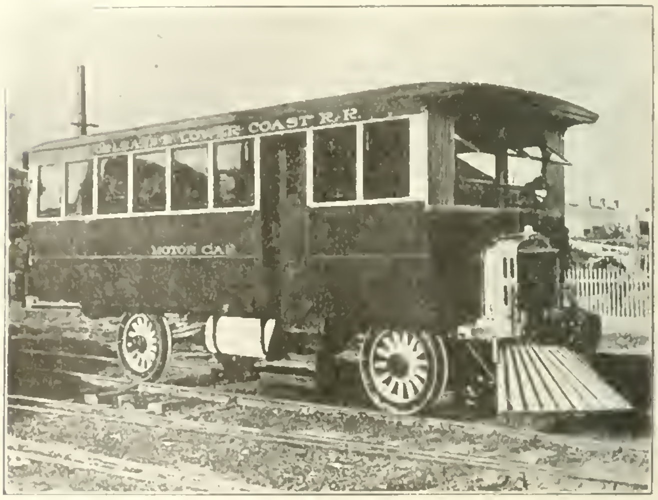
OIL BURNING SNOW MELTER.

The heavy snow-fall of the winter of 1919-20 in eastern cities resulted in the trying out of several new types of snow removal apparatus. One of these consisted of an oil burning flame projector. This device was invented by L. V. Stevens, a Canadian engineer, and has been used on the Canadian Pacific R. R. It is shown in the illustration mounted on a 7½-ton Mack truck. The truck carries an 1,800 gal. tank of crude oil and travels at the rate of 5 miles per hour. The device throws an incandescent flame some 10 ft. ahead. The oil and air are both forced ahead under compression through a mixer or carbureter, in a manner similar to the practices established in the case of blast furnaces and oil burning locomotives.


Snow Melter in Operation in Brooklyn.

MOTOR TRUCK ADAPTED FOR SHORT LINE RAILWAYS.

Filling a long needed necessity in the transportation system of the country's railroads between the long well-traveled railroad line with its abundance of freight and passenger business, and the short line run where passenger and freight transportation is carried on unprofitably because of high operation costs, the railway motor car, a virtually new adaptation of the motor truck, is coming to the aid of the common carriers in taking over this unprofitable transportation through its ability to operate on railways and carry on this work more economically and with equal efficiency. The New Orleans & Lower Coast Ry. is the most recent road to install a railway motor truck to replace a passenger train for service over a 60-mile run from Algiers to Buras, La. The internal combustion form of railroad transportation is a standard FWD truck chassis on which steel flanged wheels have been substituted for the rubber tired ones and a passenger body mounted on the frame. With the exception of the use of the flanged wheels the standard construction of the truck remains the same, the regular motor used in the truck for ordinary hauling requirements furnishing the power. The special passenger body on the car was built in the New Orleans & Lower Coast workshop and provides seating space for thirty-two persons. The entrance is from a side folding door on the forward end. The car is also equipped with Master Car Builder coupler and can be used for switching or hauling a trailer. The starting and lighting system is furnished by a 24-volt single unit system which furnishes power for four dome lights, headlight and rear marker lights. The exhaust gases from the motor are used to heat the car. This is done by means of a take-off which converts the hot gases from their regular channels through a series of pipes running at the sides, making the car as comfortable as any Pullman.



Motor Truck Car of New Orleans & Lower Coast Ry.

STEAM MELTING ASPHALT PLANT.

An improved Merriman steam melting asphalt plant has been placed on the market by the East Iron & Machine Co., Lima, O., which has been building these plants since 1905. The new plant is only 58 ft. over all, making it, it is claimed, the shortest complete railroad plant of its capacity on the market. It has a guaranteed capacity of 2,000 sq. yd. of 2-in. topping, or 2,800 yd. of asphaltic concrete, in a 10-hour day. The side sills are extra heavy girder construction. They are so constructed that they cannot sag or warp out of shape. The trucks are extra heavy, MCB. standard, with 6x11-in. journals, special hammered steel axles and chilled wheels. The arch bars are made of bar steel. The boiler is of the Locomotive type, specially built, and of 125 H.P., with a capacity of 160 lb. pressure. The power equipment is specially designed. The engines are of simplified construction, very heavy, and all parts are readily accessible. Four melting kettles are used, and to insure compactness and solidity they are constructed in one unit. Each kettle is equipped with two steam coils, made of heavy electrically welded pipe. These kettles are so arranged that air pressure can be used to facilitate discharge of the asphalt, and so that either air or steam can be used for agitation. Clean-out doors are placed at close intervals. The sand drum is of a special type of construction, and is patented. It is [illegible] in diameter and [illegible] ft. long. No internal spiders are used and four heavy I-beams act as spill plates and carry the sand so that it falls through the heat as the drum revolves. Spiral flights carry the material forward. The drive end of the drum runs on special trunnions and a special riding ring, and is driven by means of gear segments around the outside of the drum. The capacity is greater than the material required for the rest of the units of the plant, and is approximately 25 tons per hour. The mixer has a capacity of 12 cu. ft., and is equipped with special patented blades, having renewable ends. This mixer is so arranged that the material can be dumped directly into motor trucks which run under the mixer platform. The hot material storage bin is telescropic and holds 12 cu. yd. or 15 tons, so even with this extra large capacity, the bin can be easily closed down on platform without removing any parts. The working platform on which the mixer, etc., is located, is a patented arrangement. When extended for operation, it permits trucks and wagons to pass under the mixer dump. When packing the plant for shipment it is easily drawn within shipping length of the car, and clears the end of the car frame. Elevators on both sides of the plant feed the sand drum so material can be stored on either or both sides. The hot material elevator is entirely enclosed in dust-tight sheet-steel housing, made in sections, which can easily be removed to facilitate packing for shipment. The fire box is arranged for burning coal, coke, wood or fuel oil.

Improved Merriman Steam Melting Asphalt Plant.

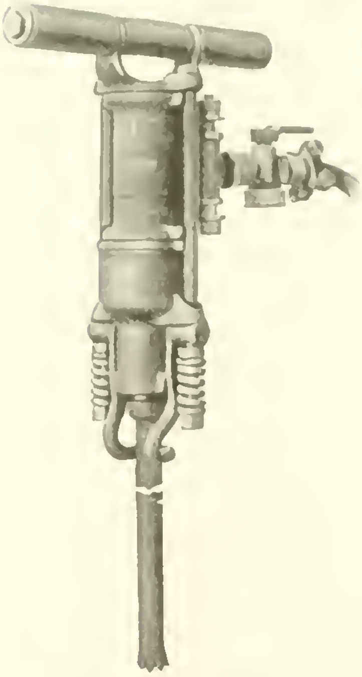
SMALL LOCOMOTIVE CRANE.

On many big construction and road jobs during the past few years the contractors have found it economical to handle a good deal of their materials by a locomotive crane. The saving effected by cranes on these large contracts has created a demand for a smaller type which can be used economically on smaller jobs. With the idea of filling this need for a smaller capacity high grade crane for construction work, a new Brownhoist Number 2 locomotive crane has been announced. This machine can be changed in a few minutes time to handle [illegible] as [illegible] drill [illegible]. With this [illegible] of materials can be handled. [illegible] the [illegible] type locomotive crane has proven [illegible] sand [illegible] gravel [illegible] are handled, and a [illegible] for handling concrete. This new crane [illegible] as the [illegible] type while [illegible] one yard bucket [illegible] 1 ton. In order to meet the different [illegible] conditions these cranes are made to operate by [illegible] engine. They are built for use on [illegible] traction wheels or crawler tracks. This new crane has just been added to the other types of locomotive cranes built by the Brown Hoisting Machinery Co., of Cleveland, O.

New Model Brownhoist Locomotive Crane.

A LIGHT WEIGHT ROTATOR DRILL.

The demand for a rotator of [illegible] weight that [illegible] came originally from abroad, since it is a common practice in many foreign fields, to hold these drills to their work by hand, even when working at or above the horizontal. To meet this requirement the Sullivan Machinery Co., Chicago, Ill., has brought out the Light Rotator, class "DP-32." This is available in solid piston, hollow piston and water tube models. The "DP-32" rotator weighs only 2[illegible] lb. It uses [illegible]-in. hollow hexagon steel and is good for [illegible]-ft. holes under average conditions. In imparting the rotation to the drill steel the piston itself does not turn. No chuck bushing is employed. The chuck is ratchet ring, chuck bushing, and chuck all in one piece and is rotated by the action of the spiral grooves on the piston. No retaining bushing is used on this drill. The buffer ring takes the place of the bushing and holds the piston from turning by means of the straight lugs. The "DP-32" drill is being used with excellent results in this country in conditions under which horizontal or upper holes are needed, when it is preferable to hold the machine by hand instead of on a mounting.



Sullivan Light Rotator, Class "DP-32."

A FUEL FEEDING DEVICE FOR AUTOMOBILE ENGINES.

The fuelizer, a device invented by the Packard Motor Car Co. and applied to its engines during most of 1920, is stated to have eliminated a number of evils which have seriously hampered the use of automobile engines. Among the advantages claimed for it are: It permits the starting of engines without difficulty no matter how cold they are; it greatly reduces if it does not entirely eliminate the deposit of carbon on the valves of the cylinders, it gives fairly satisfactory results, even with the poorer grades of gasoline which it is often necessary to use today; it prevents kerosene and other low grade elements in gasoline from forming and washing the lubricating oil from the pistons, cylinder walls and crankshaft bearings and also the dilution of the oil in the crank case by gasoline coming down through the pistons. The fuelizer operates by carrying a small quantity of gasoline direct from the carburetor to a separate spark plug. This plug ignites the gas which then circulates at a very high temperature through the fuelizer chamber which surrounds the intake manifold. At the bottom of the fuelizer chamber are two small holes through which the superheated exhaust of the fuelizer enters directly into the main intake manifold. Thus the main intake manifold temperature is raised by direct mixing with the fuelizer exhaust as well as by the heat developed in the fuelizer chamber. The result is that all gas passing through the [illegible] manifold is thoroughly dried, sufficiently heated and broken up into a completely combustible fuel. The circulation of gas through the fuelizer is maintained by the same cylinder suction [illegible] through the main manifolds. However, the [illegible] of gas through the fuelizer starts below the butterfly [illegible] and exhausts above it. Therefore when the butterfly valve is closed, the suction upon the fuelizer is very [illegible] and it receives a maximum supply of gas and gives off a [illegible] supply of heat. On the other hand, the further the butterfly valve is opened the less suction there is on the fuelizer. This automatically decreases the heat given off [illegible] in direct proportion to the decreasing need of the [illegible] heat. Thus the fuelizer goes at maximum [illegible] when the motor is starting up or is idling, but when the [illegible] an ideal combustion heat because of high [illegible] work, the fuelizer automatically shuts off [illegible] again.

The Fuelizer

A 3¼ LB. BLAST FIRING MACHINE.

A small light weight blasting machine capable of developing [illegible] to fire five 30-ft. copper wire electric blasting [illegible] five [illegible] iron electric blasting caps has been [illegible] the market by the Atlas Powder Co., Philadelphia, Pa. The [illegible] are 2 in. by 4 in. by 4½ in. in size, and [illegible] 3¼ lb. The outer case is a seamless brass tube, [illegible] with aluminum top and bottom plates. The [illegible] is substantially built to stand hard service. A leather strap [illegible] makes carrying easy. The key by which the blaster is operated is a separate part of the machine and may be kept in the possession of the shot-firer, preventing the operation of the machine by any other person. This is an important safety feature.

Davis No. 1 Blaster.

DEVICE FOR THAWING FROZEN HYDRANTS.

Initial demonstrations of a new hydrant thawing device was given a few days ago before officials of the Fire Department of New York City. The device has a steam coil surrounded by a jacket tank, which is filled with water for pumping into the steam coil. The heat for generating the steam is provided by a burner directly under the coil. The burner has ten jets, the fuel used being acetylene under suitable pressure. In the test dissolved acetylene such as the Prest-O-Lite Co. compresses into cylinders for auto truck and tractor lighting was used. In the accompanying picture, a Prest-O-Lite tank is shown attached to the steam generator and another cylinder is seen near-by in readiness for connecting when the pressure in the first cylinder runs too low for effective operation of the device. This situation would occur only in demonstration where a great deal of thawing is done. In actual practice, one cylinder would be ample for opening up any number of hydrants likely to be used at any fire. The only other necessary part of the device, is a connecting hose, one end of which serves as a nozzle to direct the steam jet in the thawing process. As soon as the acetylene jets are lighted, the operator begins pumping water slowly into the steam generating coil and the intense heat of the acetylene under pressure not only converts the water into steam almost instantly but superheats the steam so that it is what is known as "dry steam," having a temperature corresponding to that of steam produced by superheaters in locomotives. As the hose gives a permanently open outlet for the steam, no safety valve is required, but one it attached as an added safeguard.

Melting 24-in. Block of Ice with New Hydrant Thawing Device.

Water is fed continuously into the coil, being converted into steam precisely as is the case when a drop of water falls on a red hot stove. The device was invented by Louis F. Ross and is manufactured by The American La France Fire Engine Co., New York.

A NEW AUTOMATIC METER-PUMP FOR CONCRETE MIXERS.

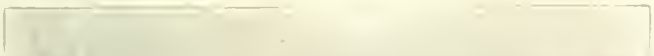
The Austin Machinery Corporation, Chicago, reports the successful conclusion of a series of tests preliminary to placing on the market the new automatic meter-pump. This device measures the water discharged into concrete-mixers and paving machines. It insures a uniformly accurate quantity for each bath. The meter is simple in both construction and operation. Setting a pin for the exact quantity of water required takes but a moment, and then no more attention is required until the job is done, except, possibly, to move the pin a hole or two to offset any variations likely to occur in the moisture of the ingredients. The device consists of a pump, a valve, a timer, and a few pipes and fittings. The pump is driven from the mixer-shaft. It works continuously, lifting water approximately 12 ft. from dead water to pump, or from hydrant. The two-way valve is "opened" and "closed" by means of a cam on the timer controlled by the starting lever. When the valve is "open" the water is discharged into a mixer, when "closed," it circulates through a return loop in the pipe. The operator "opens" the valve by throwing the starting lever over to the timing pin. Then he forgets it until the next batch is ready for water. The valve "closes" itself automatically at the precise moment the pre-determined

The Austin Meter Pump.

quantity of water has been discharged. How much or how little water is required makes no difference to this device, as it has a range of about 250 per cent between minimum and maximum discharge. Throwing the starting lever is the work of an instant and does not interfere in any way with the operator's regular duties. The total weight does not exceed 200 lb.

A NEW FOLDING DRAWING TABLE.

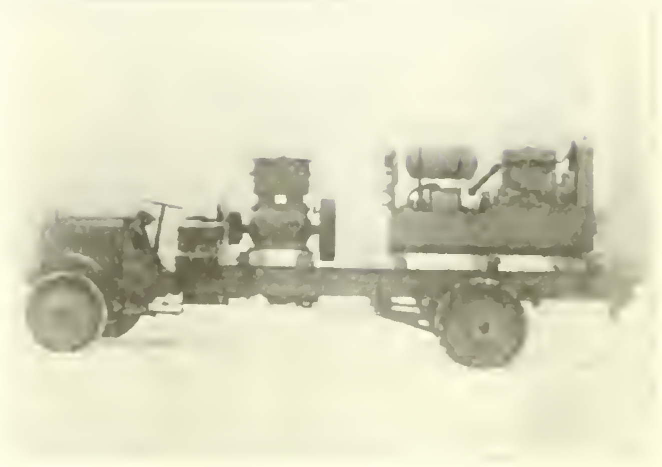
A handy folding drawing table especially designed for architects, students, schools and home use and particularly for conditions requiring a portable table that can be set up and adjusted in a moment's time and as quickly folded up and set away has been invented by H. G. Schroeter, P. O. Box 217, C. I. Toledo, O. The frame is made of formed sheet steel of the cantilever design and is put together to stand extreme weight and strain. The top is made of white pine and fastened to the frame. The adjusting device is an ingenious method of permitting the top to be adjusted to any angle and lock securely in position. The table stands 37 in. high and is adapted for any size drawing board from 23 by 31 in. to 36 by 48 in. in size. It folds to less than 3 in. in thickness.



Drawing Table Folded and in Position.

ELECTRIC WELDING OUTFIT MOUNTED ON TRUCK

One of the interesting innovations of this year has been the construction of a [illegible] truck carrying an electric arc welding apparatus for use in work in repairing ships. It was constructed for the [illegible] Corporation, New York and has been in successful operation ever since. The chief advantage of this type of installation for marine repair work [illegible] the time saved in transferring it from place to place. The previous practice had been to have [illegible] several boats [illegible] from one [illegible] to another and [illegible] the [illegible] of the [illegible] but the cost of [illegible]. The present apparatus was constructed by the [illegible] on a [illegible] Packard chassis. On the chassis [illegible] body of special design which [illegible] space for the [illegible] set for [illegible]. The [illegible] over the front axle and [illegible] driven by a [illegible] HP gasoline engine. The [illegible] capacity for two welders [illegible] to each [illegible]. The body allows plenty of room for the [illegible] to get about the power plant and give all parts the necessary attention. This arc welding machine was designed and built by the Covic Co. The body also carries two large reels, each with 1,200 ft. of copper leads which permit the two welders to work at a radius of 600 ft. from the truck. On the underside of the rear of the truck are compartments which carry welding supplies such as short lengths of wire, welding glasses, hammers, etc. There is also a 10-gal. spare fuel tank and a 25-gal. tank for lubricating oil. On the forward part of the body is mounted a 90-ft. air compressor to supply compressed air for pneumatic hammers and tools which are used by the welders. This compressor is driven by the motor of the Packard truck through a power takeoff from the drive shaft. A special transmission was designed for this purpose and a Morse chain is used to transmit the power from the drive shaft to a sprocket on the compressor. These sprockets provide for a reduction ratio of 4 to 1 in order to bring the speed of the compressor down to 250 r.p.m. A tank to store the compressed air is suspended from the floor of the body. A reel carrying two lengths of air cable of 600 ft. each is also part of the equipment. The truck is also provided with a work bench and suitable tools. It is fitted up with electric light, the current being taken from the generator and so is equipped for night work. The crew consists of six men—two welders and two chippers for welding work and an engineer and helper.



Electric Welding and Compressed Air Outfit Mounted on Motor Truck.

PULSOMETER PUMP FOR HANDLING GRAVEL AND STONE.

A pulsometer pump, designed specifically for pumping gravel and stone, and furnishes a means for drawing sand from gravel pits and river beds, and can be set up to handle material direct from its source to barge or railroad car. Stones 3 in. or 4 in. in diameter, and in some cases larger, are easily handled, for anything that passes the intake can be pumped without the slightest injury to the pump. The interior construction is so arranged that the discharge is lower than the suction valve and stones are dropped into the discharge line and forced out. The pump cannot become clogged, [illegible] the stones "pocketed." This pump has the same commendable features as all Pulsometer pumps have had for the last [illegible] years. Cams, rods, pistons, glands, stuffing boxes, [illegible] and other mechanisms are eliminated. There is no

Gravel and Stone Handling Pulsometer Pump.

friction produced at any point in operation—no parts that rub or slide together, making unnecessary the use of oil. The pump that needs no foundation or special rigging, but may be set up any place or hung from most anything. The illustration shows one of the larger sizes, but smaller sizes are made, and can be supplied to fulfill the requirements of various pumping jobs. The pump is manufactured by the Pulsometer Steam Pump Co., New York.

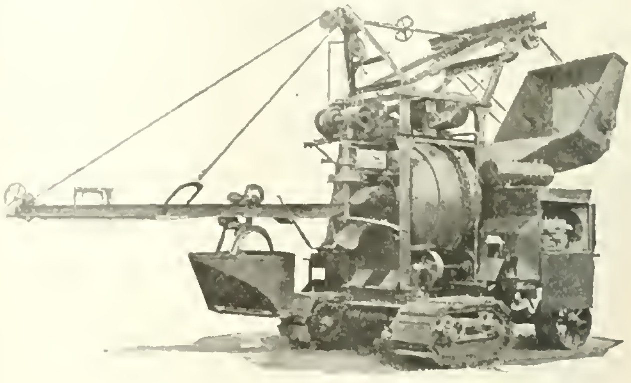
SNOW PLOW FOR TOWN AND COUNTRY ROADS.

A snow plow designed to cut a one way trail or a wide open highway sufficient to let trucks and automobiles pass each other is illustrated. This plow is built of selected Wisconsin white oak, secured by heavy forgings and castings. All runners and plow boards are bound with highly tempered steel. The deck is 8 ft. in width and the length over all is 16 ft. The sidewings are adjustable and will plow a road from 8 to 18 ft. wide. The depth of cut of the center plow is regulated by hand wheels. The plow is operated by either teams or by tractor. Hitches are provided for four teams, and as many more can be added as needed. The plow is known as the Phoenix. It is made by the Phoenix Manufacturing Co., Eau Claire, Wis.

Phoenix Snow Plow Being Operated by Two Men and Tractor.

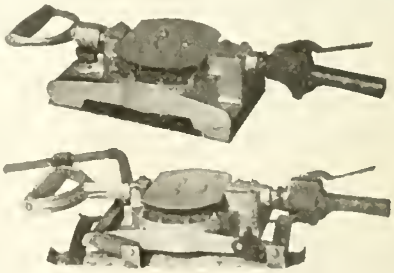
THE LAKEWOOD MILWAUKEE 14-E GASOLINE PAVER.

A late addition to the line of paving mixers manufactured by the Lakewood Engineering Co., Cleveland, O., has for its power a 4-cylinder, 25 H.P. motor, with radiator cooling system which has become standard for motor trucks and other equipment of that type. As shown in the illustration this paver is equipped with caterpillar traction. It can be furnished on trucks, if so wanted, with wheels 14 in. wide, which greatly reduces the possibility of damage to the subgrade. This machine, of course, can be equipped with the standard Lakewood batch transfer for direct charging. This batch transfer utilizes the weight of the descending skip of the paver as the lifting force to raise the batch boxes from the narrow gauge cars, and is practically automatic in action.


Lakewood Milwaukee 14-E Paver.

PNEUMATIC ADZING TOOL.

A new type of pneumatic tool, that does the work commonly done with Jack planes, adzes, draw knives and hand chisels is illustrated. The machines can be used for shaving poles, tie making, pile peeling, dapping, dock work, etc., etc. The essential feature of this tool is a turbine operated by compressed air. The shaft which the turbine rotates is extended downward, to the end of which is attached a propeller-shaped two-bladed knife, which rotates in a circular motion, each blade having a cutting edge on one side. To the body of this tool is attached an adjustable shoe, which can be readily lowered or elevated, by means of a thumb screw, to regulate the depth of cut. The air control is embodied in one of the two handles, making possible instantaneous turning on and off of the air, and starting and stopping of the device. This important feature is under constant and absolute control, at all times, when the machine is in operation, and when it is inert. The cutters revolve at a speed varying from zero to 6,000 r.p.m. It is claimed that a skilled operator of this machine can do the work of eight skilled adzemen, and perform a neater, cleaner, smoother job. The tool is made in two models. One of these is fitted with a flat shoe for use in shaping timbers, cutting gains and daps in telephone, telegraph and electric light poles and smoothing planks. The other is fitted with a curved shoe for use in taking the bark off of poles, peeling ties and shaving poles. The machines are known as "Air Planes." They are made by the Turbine Air Tool Co., Cleveland, O.


Two Models of the Air Planer, One Designed for Flat Surfaces, the Other for Curved Surfaces.

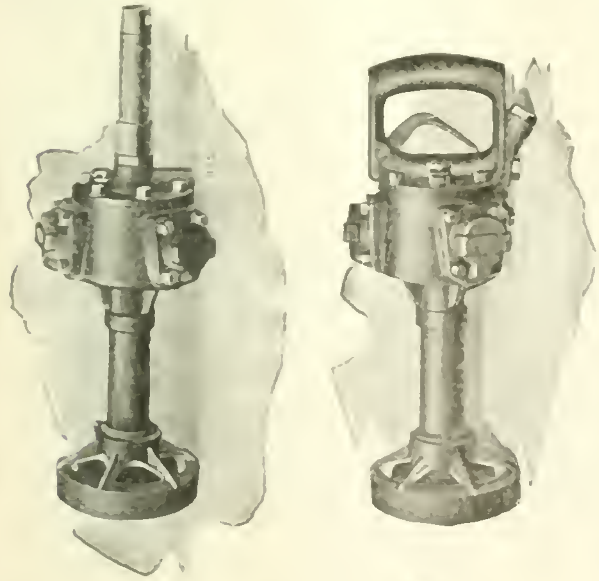
NEW SIZES OF SMALL PNEUMATIC TOOLS.

Several new sizes of small portable pneumatic tools have recently been added to the line of "Little David" Pneumatic Tools manufactured by the Ingersoll-Rand Co., 11 Broadway, New York. The new tools include a small size of close quarter drill, a small high-speed pneumatic grinder in two types and a lightweight drill furnished in two styles. These new tools have been developed to satisfy the demand for a light weight, high-speed machine for certain classes of work, for which the heavier tools were not entirely adapted.

Close-Quarter Drill.

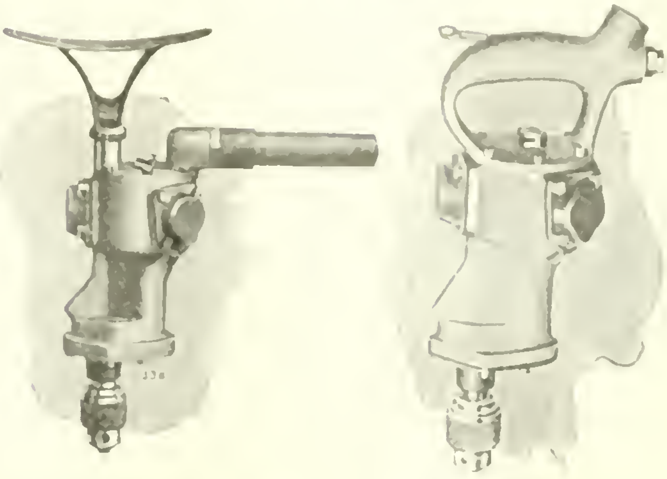
The No. [illegible] close-quarter drill is a machine for use in certain classes of work where the ordinary machine is not suitable, as close to a wall or corner. This new machine has a [illegible] high speed running at 250 r.p.m. without load, but will handle drilling, reaming or tapping up to 1¼-in. diameter. The tool is throughout a special design for close-quarter work and has several unique features. The spindle which turns the drill, reamer or tap, is operated by three rocking levers connected directly to the pistons through connecting rods. The motor is of the three-cylinder type with pistons acting at right angles to the levers. A very steady, continuous movement of the spindle is obtained as one ratchet pawl is always in contact with a tooth of the spindle. The construction is very simple and sturdy, with least number of parts.

The two pneumatic grinders are lightweight, high-speed tools running with a free speed of 4,200 r.p.m. and suitable for grinding, buffing or polishing work of a varied nature. Both machines have the same motor, but are equipped with different throttle and handle, one having the closed type of inside trigger handle, while the other is fitted with the rolling type of throttle handle. A special feature of these tools is the three-cylinder motor—very different from that of the drill, described above—which runs constantly in a bath of oil, insuring lubrication of all the parts. Lack of proper oiling has been one of the reasons for most grinder troubles in the past. The valve is made integral with the crankshaft, simplifying the design, and the piston and connecting rods are also of unique construction; ball and roller bearings are used throughout. The removal of a few screws enables the handle to be lifted off and exposes the entire mechanism to view, making easy inspection of the parts.



Light Weight Drills.

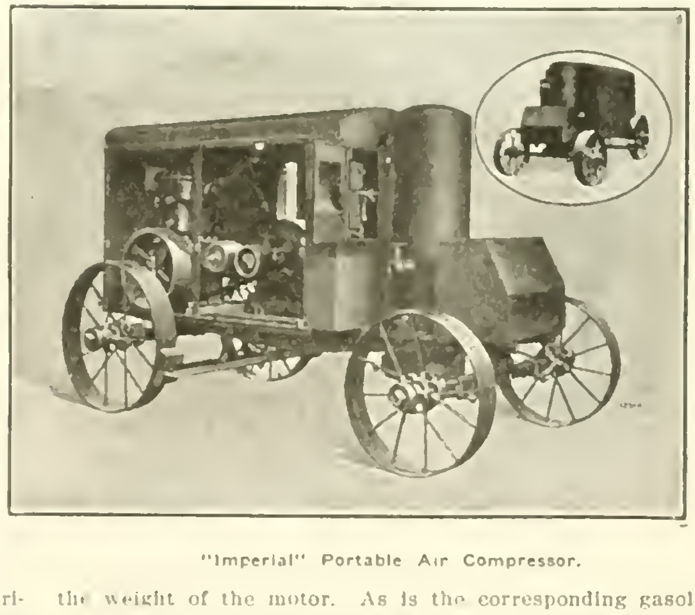
The lightweight drills were designed to meet the demand for a light air tool for drilling small holes without breakage of drills. They will handle twist drills from the smallest size up to ⅜-in. diameter. The free speed at 90 lb. air pressure is about [illegible] r.p.m. The two machines differ essentially in the [illegible], the motors being the same. One has the [illegible] handle while the other is furnished with [illegible] and rolling throttle handle. Aluminum reinforced with [illegible] bushings, is used wherever possible and results in a very lightweight machine weighing only [illegible] lb. The motor is a three-cylinder type somewhat similar to that used in the grinders above. The cylinders are separate iron castings, easily accessible, renewable and are interchangeable. A very sensitive throttle control has been obtained, which with freedom from vibration makes the tool ideal for drilling with small drills.



Two Types of Pneumatic Grinders

MOTOR DRIVEN PORTABLE AIR COMPRESSORS.

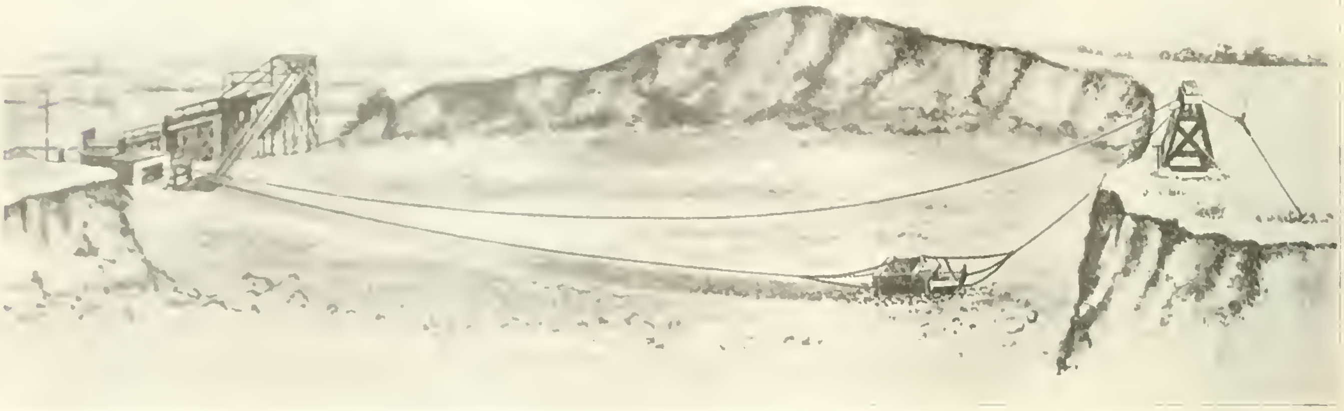
To meet the ever-increasing needs of the contractors, street railways and public service companies, having available electric current, an electric motor driven compressor has been added to the line of portable air compressors made by the Ingersoll-Rand Co., New York. This unit is of 103 cu. ft. capacity and weighs approximately 4,150 lbs., depending upon the weight of the motor. As is the corresponding gasoline motor driven compressor, this electric unit is an all-steel outfit from its sheet canopy to the broad tired steel wheels. Light steel doors completely house the entire unit protecting it from the weather. These doors are easily removed to allow free access to all parts. Suitable intake unloader is provided assuring efficient regulation. Either alternating or direct current motor can be furnished. In any case, the motor control is in accordance with standard practice and specifications covering the type of motor used. Additional equipment includes air receiver, safety valve, drain valves, pressure gauge and service valves to which air hose lines may be connected.



"Imperial" Portable Air Compressor.

STANDARDIZED INSTALLATIONS OF POWER SCRAPERS.

To make mechanically operated drag scrapers a more thorough success, Sauerman Bros., engineers and manufacturers, 322 S. Dearborn St., Chicago, have developed standardized installations of their bottomless power scrapers. Different types of installations have been perfected, adaptable respectively to handling sand and gravel, stripping or general excavating work, and storing and reclaiming coal and other loose materials. Results of the past year have indicated that the maximum efficiency of the power scraper is best realized when the proper double-drum hoisting engine, blocks, sheaves, wire rope and anchorage are assembled in a complete installation to fit certain typical conditions and requirements. These standardized installations have been particularly successful since their adoption by a number of commercial gravel producers and county road commissions who had hillside gravel deposits. Outside the excavating field, the chief development of the past year has been an extensive improvement in the application of power scrapers to the ground storage and reclaiming of coal at industrial plants.

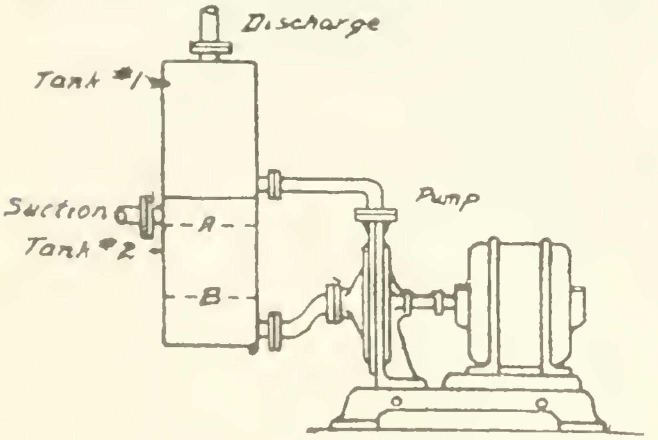


Bird's-Eye View of a Complete Power Scraper Installation for Excavating Hillside Gravel Deposit, as Designed and Installed by Sauerman Bros.

AUTOMATIC PRIMER FOR CENTRIFUGAL PUMPS.

An automatic primer claimed to be adapted for any condition where centrifugal or other valveless pumps are used, and where it is necessary to maintain a vacuum on a suction line, has been brought out by the Automatic Primer Co., 420 Conway Bldg., Chicago.

The arrangement is shown in the accompanying diagram.

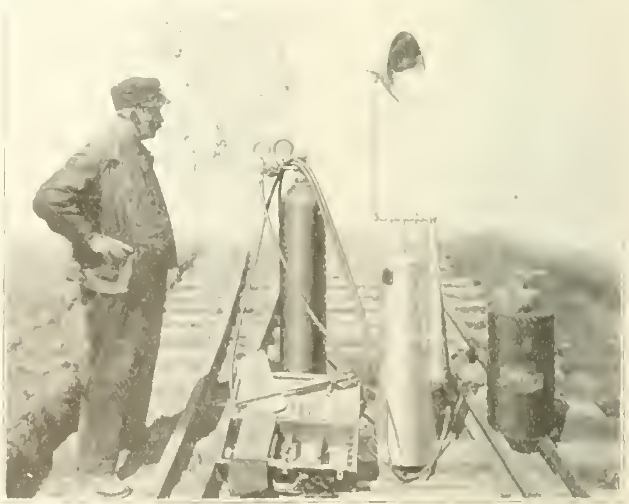


Arrangement of Priming System.

Tank No. 2 is filled with liquid to level A and the pump started. This lowers the liquid to level B but in so doing produces a vacuum in tank No. 2 and starts the liquid flowing through the suction line. While pumping, tank No. 1 is always filled with liquid. When the pump is stopped the liquid in Tank No. 1 returns by gravity to Tank No. 2, forcing the air back through the suction, thus flushing the suction line and repriming the system. Each tank has a capacity approximately one-third greater than the volume of air or gas in the suction line when expanded to the vacuum of operation.

COMBINATION PORTABLE LIGHT AND OXY-ACETYLENE CUTTING TORCH OUTFIT.

The average contractor often needs artificial lighting and oxy-acetylene apparatus even though he does not use either one of them continuously. To meet this need the Carbic Manufacturing Co., Duluth, Minn., has put on the market a combination portable light and oxy-acetylene equipment. The light can be used whenever night work is to be done. The oxy-acetylene torch is used for cutting steel beams, steel piling, reinforcing bars and often for clearing up tangled masses of iron and steel incident to the reconstruction of burned buildings. The Carbic system produces the acetylene from carbic cakes which can be bought in drums. They insure a steady supply of acetylene and when it is desired to shut off the supply, they can be lifted out of the water and saved for future use. The combination lighting and cutting outfit consists of one combination light and cutting generator; one 25 ft. length of ⅜-in. double strength oxygen hose; one 25-ft. length of ⅜-in. double strength acetylene hose; four ⅜-in. hose clamps; one Carbic cutting torch; four cutting nozzles; one wrench for torch; one oxygen regulator with one high and one low pressure gauge; one wrench for regulator; one pair of leather-palmed gauntlets; one pair of goggles with double interchangeable lenses; one friction lighter; one carrying case; one drum of carbic cakes, and one instruction book.



Combination Portable Light and Oxy-Acetylene Equipment.

MACHINE FOR SHARPENING WELL DRILLS.

A machine for sharpening well drills has been developed by Wood Drill Works, Paterson, N. J. It is claimed this machine will sharpen a drill in about 5 minutes, and make a cleaner, neater and truer job than can be obtained by blacksmithing methods customarily used for sharpening well drills. The machine is simply an adaptation on a 5-in. rock drill with certain modifications, to the new purpose.

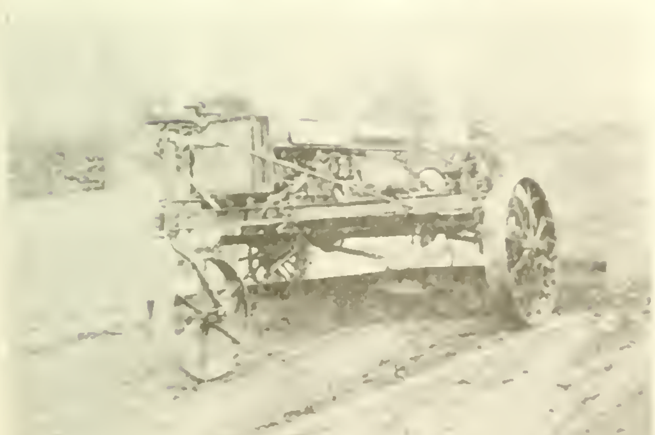
GUTTER ATTACHMENT FOR ELGIN STREET CLEANING MACHINE.

A gutter attachment which increases the capacity of the Elgin street cleaning machine was brought out last year. This attachment cleans the gutters and scatters the refuse across the width of the machine so that the cylindrical broom under the driver's seat can get it and place it on the conveyor for transportation to the collection hopper. The gutter broom is made of steel wire and will last about 4 weeks of heavy duty. It works in a vertical position and is tilted so that the outer edge will get into the corner made by the curb and gutter. The tilt may be varied at the operator's discretion to meet different sorts found in the gutter. This additional broom gives the scope of machine a cleaning capacity [illegible] as the diameter of the center broom is 2 ft.

Elgin Equipped with Gutter Attachment

A 1-MAN EARTH ROAD MAINTAINER.

This illustration shows a special road maintainer attachment attached to one of the Avery Motor Cultivators. Mr. C. E. Miller, [illegible] at the Omaha Branch House of Avery Co., worked out this special attachment to this machine for maintaining the roads in the Nebraska territory. The maintainer attachment consists of three blades which can be adjusted to the curvature of the road. This machine is especially adapted for going over the road directly after a rain and smoothing up the rough places. One man can operate the tractor and maintainer at the same time, and as he is right near the maintainer he can watch its operation carefully. The blades of the maintainer are wide enough and can be adjusted to such an extent that the road can be smoothed down by going over it one or two times.



Special Road Maintainer Attachment on Avery Motor Cultivator.

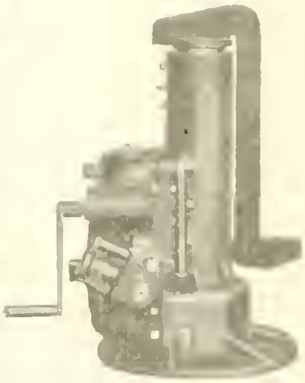
NEW MOTOR-DRIVEN STREET SWEEPER.

A motor-driven sweeper that follows the street and sweeps it, placing the refuse in the center, was brought out by the Elgin Sales Corporation, New York. The new machine follows the specifications of the [illegible] having three wheels, air pressure, spraying system, similar brooms, etc. It is able to travel in and around traffic very easily and the broom itself is heavy and powerful. An advantageous feature is that the broom may be changed to [illegible] to the left instead of to the right. This may be done at the [illegible] and requires about three [illegible] work. Thus the machine may be converted into a machine [illegible] gutter [illegible] a pick-up machine that [illegible] to the curb [illegible] up the left side of the street. The sweeper has a speed of 6 to 8 miles per hour and cleans a path 7 ft. wide.

The Elgin Auto Sweeper

A NEW HIGH SPEED BALL BEARING SCREW JACK FOR HEAVY LIFTING.

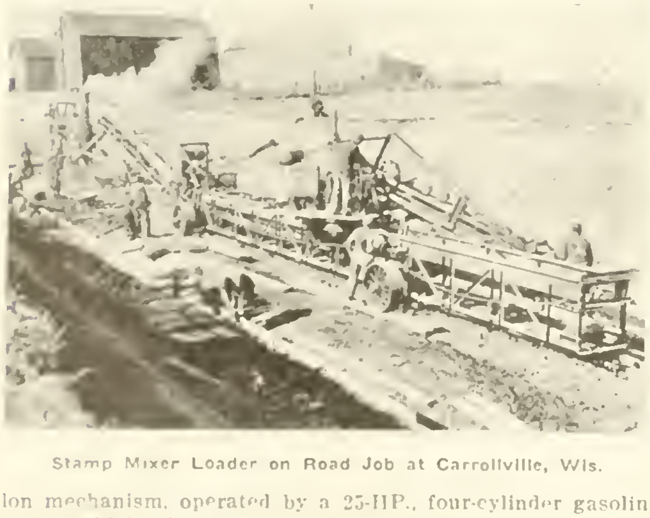
Several novel features of construction are embodied in the latest design of Duff high-speed, ball-bearing screw jack, a tool which is particularly adapted for bridge work and other purposes where a lifting capacity of 50 and 75 tons is required. The most noticeable thing is the fact that the operating mechanism, instead of being located in the head, is placed in the base. The greater weight is thus put at the bottom instead of at the top so that the jack is not top-heavy. Another advantage is that the point at which the operating lever is pivoted does not rise with the load. This allows a full, powerful stroke, regardless of the height of the load. This newly designed jack is unusually easy to move about. Not only does the concentration of weight in the base make it easy to handle but by inserting the operating lever in special sockets, the jack can be tipped over by one man and rolled on its own sturdy wheels wherever needed. The load is raised by means of a 6-ft. steel lever which operates a double-thread screw through a ratchet and gearing. The screw has a very steep pitch, making the action extremely rapid. The screw is made of special machinery steel, heat treated, and turns in a bronze nut of special composition. This combination of bronze and hard steel materially reduces friction. Absolute safety is stated to be assured by a positive clutch which holds the load at all times, preventing any possibility of it sinking or lowering. Another safety feature is the signal which is provided to indicate when the jack has reached its maximum height. For lowering, a crank handle is used. A few easy turns are all that are required as the action is very rapid. Regardless of the speed with which the load may be descending, it is claimed that it may be stopped with absolute safety at any point desired. The action is positive, so there is no possibility of sticking. This new high-speed ball-bearing screw jack, built by the Duff Manufacturing Co., of Pittsburgh, is made in two capacities, 50 and 75 tons maximum. Both the 50 and the 75-ton jack are supplied in a variety of heights to suit requirements.



New Duff High Speed Ball Bearing Screw Jack.

A MECHANICAL CONCRETE MIXER LOADER.

A mixer loader that is a combination of a bucket loader which elevates material from ground storage piles into measuring hoppers and a belt conveyor which carries the materials from the hoppers to the paving mixer, is illustrated. It consists primarily of a long longitudinal structural framework, mounted on self-propelled truck wheels with the rear end inclined upwardly. A rubber belt conveyor of standard design is mounted in the lower part of this steel framework. This runs continuously and material dropped onto it is carried at a speed of 100 ft. per minute and discharged into the mixer skip. The top of the framework carries the elevating unit or "digger elevator." This is mounted on wheels and is movable back and forth over the top of the longitudinal frame. The "digger elevator" is of standard design with large malleable iron buckets attached to steel chains. It is mounted on a turntable supported by wheels and arranged so that the end can be raised and lowered and also swung in a complete circle. A separate four cylinder gasoline engine is used to drive this digger elevator and is controlled by an operator stationed on a platform supported by the digger frame. It is fitted with power feed back and forth along the frame and the digger-elevator is equipped with a power swinging, raising and lowering mechanism. In this way the operator can quickly and easily adjust it to dig at any part of the material piles, on either side of the machine. The buckets when worked to full capacity will elevate, it is claimed, about ¾ cu. yd. per minute. The buckets never work closer than 3 or 4 in. from the ground. A man who can be trained to be careful, cleans up the material and shovels it into the buckets. The digger-elevator discharges into a measuring hopper which is mounted on wheels above the belt conveyor and which can be moved back and forth along the frame. This measuring hopper consists of a number of adjustable, graduated compartments and is moved along the frame by operating a cable extending the length of the frame. The digger elevator fills up the hopper to measure the material and thereafter a door in the hopper is opened which drops the measured batches on the belt conveyor. Only one digger-elevator is necessary. This handles both the sand and stone. The compartments of the hopper are adjusted to contain sufficient sand for a batch. The correct stone level is marked and two stone hoppers are discharged to each one of sand, the three hoppers making a complete batch. To begin, all compartments of the hopper except one, sufficient for about 6 to 9 batches, are filled with sand. Then the digger is swung to work on the stone pile. As the compartments of sand are emptied (one to a batch) they are refilled with stone. In this way the hoppers serve as a storage for one material while the digger is working on the other. The digger operates approximately during the time required for three or four batches on sand and six to eight batches on stone.

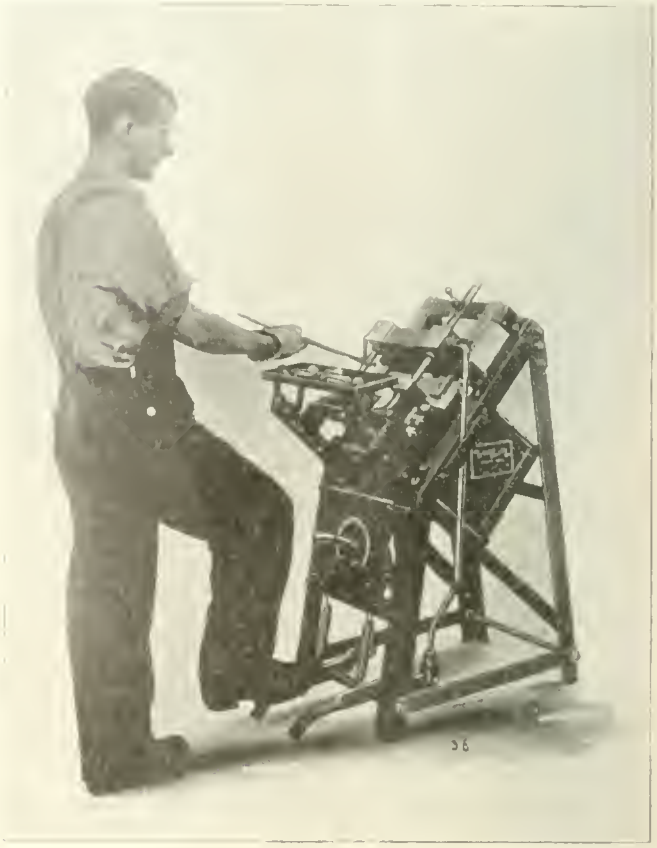


Stamp Mixer Loader on Road Job at Carrollville, Wis.

The loader is equipped with a forward and reverse traction mechanism, operated by a 25-HP., four-cylinder gasoline engine which also operates the belt conveyor. It is also equipped with a four-wheel steering device which makes it easy to turn corners at a small radius and to rapidly move the loader into any desired position. It can be moved anywhere it is possible to use the paving mixer. The front end of the frame can be raised so as to permit considerable clearance between the extreme front point and the ground. The front section beyond the wheels and the rear inclined section can be easily disconnected for shipment. The main framework, with the digger-elevator, will occupy the length of a flat car. The mixer loader is made by the Stamp Machine Co., Milwaukee, Wis.

ELECTRIC RIVET HEATING MACHINE.

A new type electric rivet heating machine covered by Patent No. 1354859, issued Oct. 5, 1920, is being placed on the market by the Taylor Welder Co., of Warren, O. The outfit is made up of angles and plates to reduce its weight to a minimum, so as to make it easy to move from place to place. The outfit illustrated is designed to be set on the floor or a platform, where it would be permanently installed. It can, however, be provided with a bail so that it could be picked up by a crane and moved from place to place. The illustration shows an outfit designed to heat two rivets simultaneously, although it can be built for any number of rivets in multiples of two. In most instances, however, a machine of this type will heat rivets sufficiently fast, to keep one rivet boy busy removing hot rivets and inserting cold ones. The time required for heating a rivet ¾-in. by 4-in. size is stated to be in about 30 seconds. This outfit is equipped with a 15 KW transformer, a 5 step shelf contained regulator for controlling the heat and adjusting same to various size rivets. Air is used for cooling the transformer, which however is of sufficient capacity to prevent any undue rise in temperature due to its being in constant operation. The outfit is foot operated, leaving the hands entirely free to care for the work and a 6-in. by 16-in. rivet tray is placed in a convenient position to hold a quantity of rivets to be heated. The dies are 32 in. from the floor and the extreme height is approximately 40 in. The outfit complete will weigh about 400 lb.



Rivet Heating Machine.

PORTABLE POWER MACHINE FOR STUMP BORING.

A power auger for boring stumps preparatory to blasting them has been placed on the market recently by the Cowan-Alford Boring Machine Co., Inc., Macon, Ga. The power is supplied by a Cushman 4½-HP. gasoline engine mounted on a steel [illegible] track. The [illegible] gear. The [illegible] lateral adjustment alongside the [illegible] which the bit is fitted. A hand wheel [illegible]

Stump Boring Machine Operating Under Field Conditions.

control, and he does not get off the platform. The equipment includes one auger, 2-in. diameter by 30-in. twist. It is claimed that this machine will drive a 2-in. bit into sound resinous wood at the rate of 32 in. in one minute or less.

EXCAVATING BUCKET WITH LEVER ARM CLOSING MECHANISM.

A bucket designed to have great digging power but still close very readily has been placed in production by the Blaw-Knox Co., Pittsburgh, Pa. There are two sheaves in the cast steel lever and the bucket is reeved with four parts of line. However this bucket may be reeved with three parts of line, omitting one lever arm sheave. The bucket is particularly recommended by the manufacturer not only for all kinds of dredging work under water, but also for excavation in earth, clay and packed gravel or sand. It is also adapted for rehandling crushed stone and other materials that are not easily gathered up. The primary objects of the lever arm type of closing mechanism are: To reduce the number of sheaves required in the block and tackle closing mechanism; to obtain a better [illegible]

"Dreadnaught" Bucket.

A 1-MAN ROAD MACHINE.

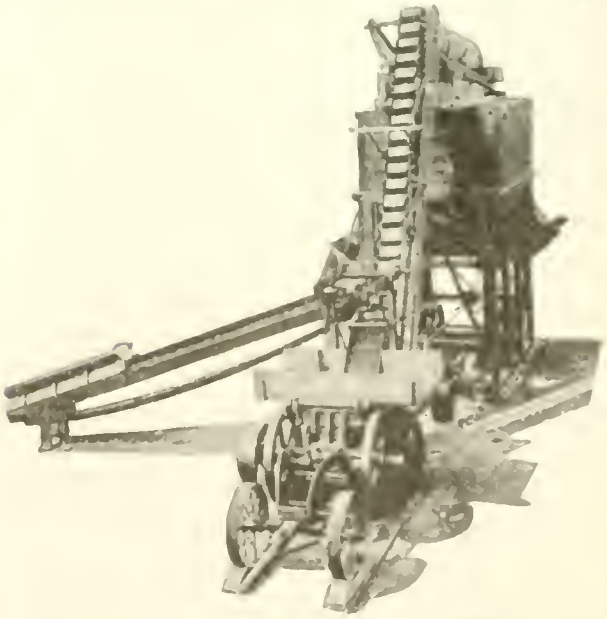
[illegible] Power Patrol, [illegible] Tractor Co., Minneapolis, Minn. [illegible]

The Shawnee Power Patrol.

part of the tractor frame [illegible] in a single massive unit. When once the shafts are fitted into this unit casting they are therefore staying in perfect alignment. The wheels are given special attention, the spokes being [illegible] welded at both the rim and hub. The radiator is especially designed to keep the motor cool even when the most severe demands are made upon the power plant. It will keep the motor cool to the point where the machine can be worked on low gear steadily. The Shawnee Power Patrol is strictly a one-man machine, easy to steer and operate. It has two speeds forward, and one in the reverse. The entire machine turns easily on a 16-ft. width of road.

PORTABLE GRAVEL CRUSHING AND SCREENING PLANT

A standardized gravel crushing and screening plant that can be moved from job to job with a minimum of difficulty was put on the market by the Austin-Western Road Machinery Co., Chicago, Ill. A hand crank is used to raise and lower the screen and elevator. When ready to move, the screen is lowered into the bin by means of this crank and at the same time the elevator folds up. An 8 h.p. gasoline engine is mounted under the bin, where it is well protected from dirt and provides power for the whole outfit. An automatic gravel feeder and grizzly screen can be furnished as part of the equipment. The bin has three compartments with a total capacity of about 25 tons. The screen is 8 ft. long and 32 in. in diameter and the elevator, it is claimed, will handle up to 400 or 500 tons a day.



Western Portable Gravel Crushing and Screening Plant.

TROLLEY CARRIER SYSTEM FOR HANDLING COAL, STONE, ETC.

Among the new mechanical equipments which have been developed during the past year is the American trolley carrier, a general layout of which is shown in Fig. 1. This equipment, put out by the Conveyors Corporation of America, Chicago, has been developed primarily for handling coal in power plants and retail coal yards, but is applicable to the handling of a variety of bulk materials such as coke, ashes, sand, gravel, crushed stone, cement clinker and earth fill. This trolley carrier consists either of a single line, automatic bottom-dump bucket operated on an overhead monorail track, or cableway by a two-drum hoist (shown), or of a two-line grab bucket from ¾ to 4 cu. yd. capacity operated in the same manner by a three-drum hoist. The single line bucket may be operated on a curved track with anything up to a 90 deg. bend. A feature of this single line bucket rig is the automatic discharge mechanism. The bucket is provided with a sliding bail through which the contents are supported by means of flexible cables directly on the doors which form the bottom of the bucket. Thus it is impossible to discharge the bucket while in transit. In order to discharge its contents it is necessary to bring the bucket to rest either on the ground or top the pile. The sliding bail then falls of its own weight—through the guides on the side of the bucket until the catch engages with the rigid, or secondary bail. When again lifted, the bucket proper is supported by means of the latch through the rigid bail, and the bottom doors are left unsupported and therefore open. Thus the material is deposited without breakage directly on the ground or top of the pile. The bucket is loaded by dropping it into a pit next to the railroad siding and receiving the material through a gate from a hopper beneath the track. The loading pit is provided with angle iron rails which engage with flanged wheels mounted on the sliding bail and prevents the bucket from tripping. A second feature of this equipment is the flood oiling device used on all sheaves and trolley wheels. The sheaves are cast in two parts leaving an internal oil chamber in the hub. A quantity of oil is placed in this chamber and is circulated by centrifugal force, through a two-way scoop projecting from the shaft, along the shaft and returned again by centrifugal force to the oil chamber. These sheaves will operate for 12 to 14 months without attention. The hoists may be driven by either an electric motor, or a steam or gasoline engine. In all cases a direct gear connection is used unless local conditions make a belt or chain drive desirable. The single line-bottom dump bucket rig is applicable to all cases where material is received in bottom dump cars and is to be delivered either to overhead bins or ground storage piles. But where material is to be taken from the tops of cars, from barges, or is to be reclaimed from storage, the two line grab bucket rig is used. Cableways are sometimes arranged with the outboard tower moveable so that material may be stored over a large area. A single line grab bucket may be used to replace the bottom dump bucket on the single line rig for use in reclaiming from ground storage piles. The single line rigs will, it is stated, handle coal at the rate of 30 to 40 tons per hour, while the two-line grab bucket rigs will develop capacities up to 150 tons per hour.

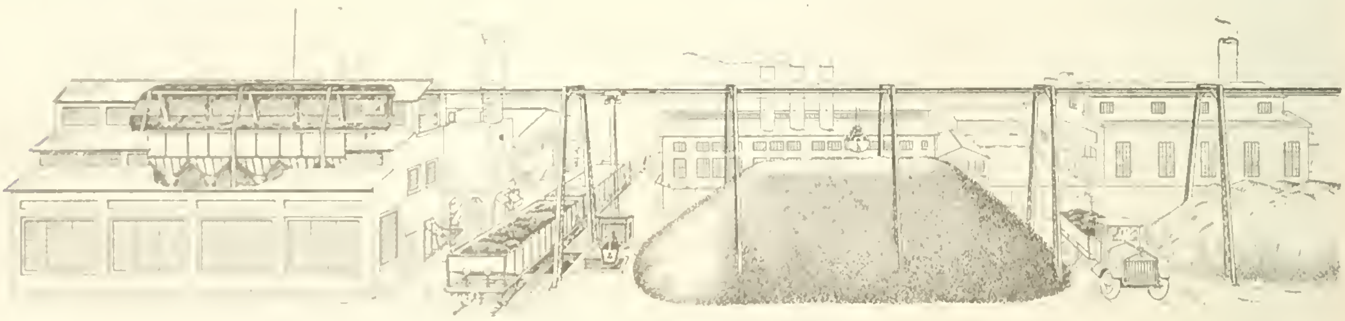
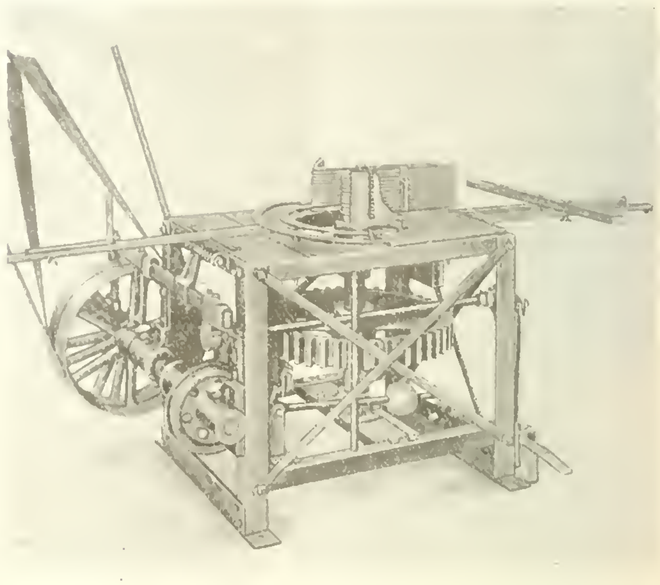


Fig. 1.—General Layout of American Trolley Carrier.

A POWER-DRIVEN STIRRUP BENDER.

A power driven stirrup bender, designed to bend as many as 20 stirrups in one operation, has been added to the line of bar benders made by Kardong Bros., Minneapolis, Minn. The bender is equipped with gages, levers, and is otherwise fully equipped to make bending fast, accurate and uniform. It is stated that with this machine a man of ordinary intelligence can bend stirrups at the rate of 400 an hour. The machine was designed about 4 years ago and has been in service in the company's plant continually, during which time many improvements have been added, and has recently reached the stage of perfection. Owing to its simplicity of operation, increased output, and accuracy of measurements it has proven itself to be a great time and labor saver. Kardong Bros. also have recently perfected another new product, a milling machine, used for milling the ends of column bars which will be placed on the market shortly. This machine is driven by power and is so constructed that it can be used for field or shop work equally well. Between 100 and 150 ends an hour can be milled, the output depending upon the conditions surrounding the work.



Power Driven Stirrup Bender.

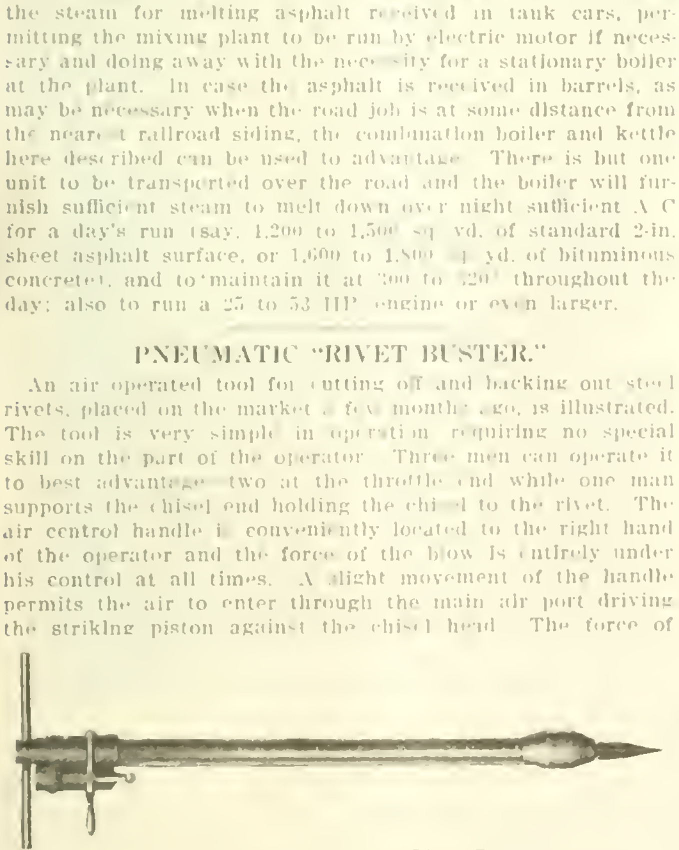
COMBINATION ASPHALT KETTLE AND STEAM BOILER.

A combination steam melting kettle and boiler designed for use in connection with portable asphalt plants has been patented by C. F. Hetherington, Indianapolis, Ind. The boiler is a plain cylindrical flue boiler with the addition of return tubes. It is designed for 200 to 250 lb. working pressure. A. S. M. E. specifications. The shell of the boiler is extended sufficiently beyond the front and rear tube sheets to form a support for the front and rear axles, respectively, and also at the rear end to form an attaching ring for the fire box. The fire box is arranged with grates and also provided for burning fuel oil, so that either fuel may be used at will and without any rearrangements. The asphalt in the kettle is in contact only with a steam or hot water heated surface and, as the furnace gases at no point come in contact with the outer shell of the boiler, the asphalt is at no point heated beyond temperature of the steam. Consequently those contractors who favor steam melting or are obliged by specifications to use only the steam melting system will appreciate this feature of this melting plant. For use with the harder asphalts there is provided a steam super-heater coil in the front end of the boiler flue. This would not be required for the softer asphalts, but in using Trinidad asphalt better time could be made in melting it and the heavier ingredients of the material kept in agitation by using the super-heater coil for blowing steam. The plant is so designed that this coil may be readily removed or replaced in a few minutes without interfering in the operation of the plant. In addition to the heating surface provided by the external surface of the boiler shell, steam coils are provided so that lump asphalt may be melted down and its temperature raised to 320° F. within 6 or 8 hours after charging the kettle. These coils are arranged in banks which are easily removed from the top of the kettle, although it is probable that there would never be any occasion to remove them during the operating season because the coils are made of continuous welded extra heavy pipe. The combined plant is carried on four wide-faced traction wheels. The axle being pivoted in the center so that the superstructure is entirely protected against twisting strains in movement over the roads. The boiler can be used not only for heating the asphalt in the kettle but also for furnishing the steam for melting asphalt received in tank cars, permitting the mixing plant to be run by electric motor if necessary and doing away with the necessity for a stationary boiler at the plant. In case the asphalt is received in barrels, as may be necessary when the road job is at some distance from the nearest railroad siding, the combination boiler and kettle here described can be used to advantage. There is but one unit to be transported over the road and the boiler will furnish sufficient steam to melt down over night sufficient A C for a day's run (say, 1,200 to 1,500 sq. yd. of standard 2-in. sheet asphalt surface, or 1,600 to 1,800 sq. yd. of bituminous concrete), and to maintain it at 300 to 320° throughout the day; also to run a 25 to 53 HP engine or even larger.

Single Unit Asphalt Heating Kettle and Boiler

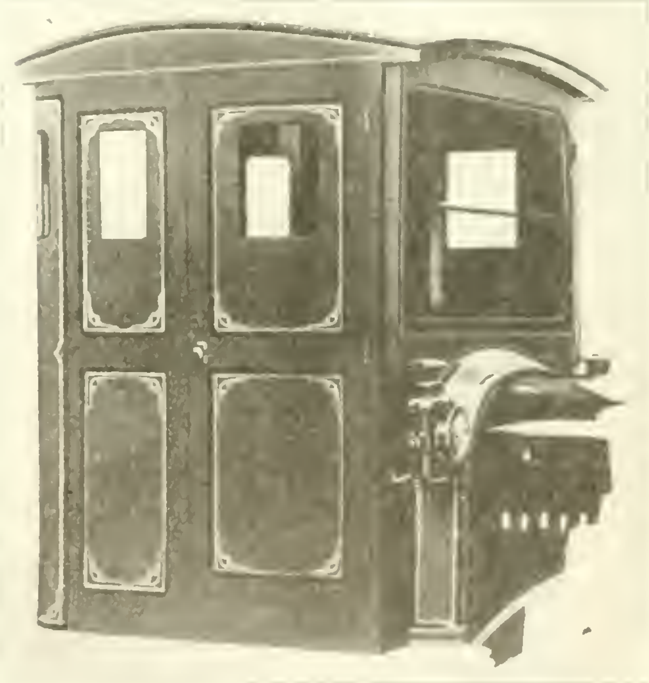
PNEUMATIC "RIVET BUSTER."

An air operated tool for cutting off and backing out steel rivets, placed on the market a few months ago, is illustrated. The tool is very simple in operation requiring no special skill on the part of the operator. Three men can operate it to best advantage, two at the throttle end while one man supports the chisel end holding the chisel to the rivet. The air control handle is conveniently located to the right hand of the operator and the force of the blow is entirely under his control at all times. A slight movement of the handle permits the air to enter through the main air port driving the striking piston against the chisel head. The force of the blow can be made heavy or light, as the operator desires, to suit the conditions of the work in hand. The handle is then moved to the exhaust port causing the piston to return to the head of the tool ready for the next blow. On the return stroke of the piston the movement is effected quickly so as not to retard the speed of the tool yet there is no perceptible "kick-back" to jar the operators and make it difficult to hold the chisel to the work. In numerous competitive tests the tool has demonstrated conclusively that it will cut off 7/8-in. and 1 in. rivets [illegible] in from four to six blows. The operating weight of the tool is 82 lb. The piston is 1¼ by 9 in., the length of stroke is 11 in., the length of chisel outside tool is 7 in., and the length of tool over all is 67 in. This "rivet buster" is made by the Keller Pneumatic Tool Co., Chicago.


Keller-Master "Iron Mule" Rivet Buster.

WINTER CAB FOR TRUCKS.

To meet the demand for an enclosed cab for cold weather the Acme Motor Truck Co., Cadillac, Mich., has developed the enclosed winter cab illustrated below. This new type, like the standard Acme cab, is substantially constructed of best quality oak. It is built around the standard seat box and is therefore readily applied to the trucks now in service. It is well ironed at points of [illegible] to stand up under service equally as well as the standard Acme cab. Side sections consist of waterproof veneer panels, curving towards the rear with curved sheet metal corner construction running full height as in the open cab. An opening 5¾x11¼ in. is provided in each corner. This is fitted with Pyralin so the driver has a clear view of traffic approaching from either side. The back of the cab is fitted with sliding windows, easily closed and opened for ventilating purposes. Each side panel has a 6x11 in. Pyralin light. The doors run full height of cab with a 9x11 in. Pyralin light which can be increased approximately to 10x15 in. Doors swing toward the front and are provided with lock designed to prevent rattling.


Winter Cab for Motor Truck.

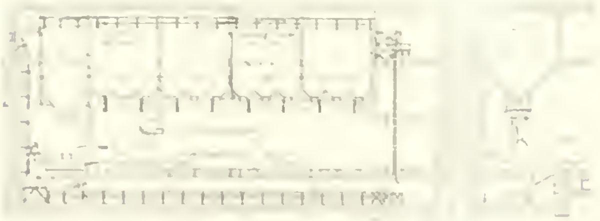
TRACTOR WITH POWER STEERING DEVICE

One of the special features of a 10-70 tractor manufactured by Kinnard & Sons Mfg. Co., Minneapolis, Minn., is a power steering device which enables the operator to guide the tractor by its own power. It not only relieves the operator of hard, unnecessary labor, but saves valuable time as well, when it is realized that in road work frequent turns have to be made in limited space. This tractor will, it is stated, easily handle two 12-ft. girders. The next smaller tractor made by this company pulls one 12-ft. girder or its equivalent. Two smaller sizes, the 20-35 and the 11-21, are used for maintenance work. All the tractors are kerosene burning and are equipped with valve-in-head motors of the company's own manufacture.

COAL AND ASH HANDLING MECHANISM FOR AN OFFICE BUILDING

By W. F. LEGGETT

The heart of the office building's service equipment is the central light, heat and power station which is housed in sub-



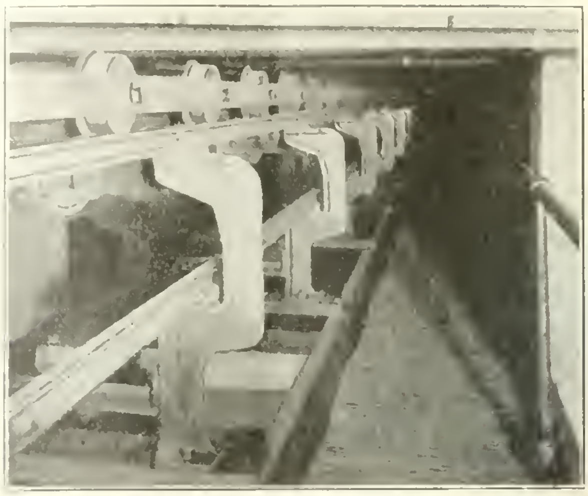
Elevation Showing Arrangement of Coal and Ash Bunkers.

surface regions where the occupied space offers no possibility of producing rental income. Because power plant coal and ash handling systems should be characterized by directness and simplicity, some engineers are inclined to crowd the equipment into space that is entirely inadequate for normal operation, but most engineers make ample provision for the plant and its accessories. The layman infers that a series of standard specifications can be made to cover average conditions, thus enabling a purchaser to select coal and ash-handling equipment in much the same manner that he chooses a talking machine or an automobile. However desirable this might be, it is a fact that each installation is a law unto itself, and while there are certain combinations of equipment that are adaptable to power plants of the same size, yet each installation will warrant special study by experienced engineers, to the end that the equipment will be correctly designed, and each part in proper articulation to the system as a whole.

Usually the office building power plant is located alongside an alley and runs to a depth of four basements below the street level. Immediately below the ground level is the first basement, and the only part of this space that is related to the power plant is the relatively small area required for the heads of the coal and ash bunkers, and the conveying machinery for carrying coal and ashes to them. The second basement contains the engine rom, the boilers, however, extending through the combined height of the second and third basements. The fourth basement, which is below the boiler room floor, is used exclusively for ash disposal. The illustration shows two sectional elevations of the complete equipment. The top line of the plan is the ground floor of the building, and at the right of the longitudinal section, the drawing plainly shows the four basements from ground floor to ash level.

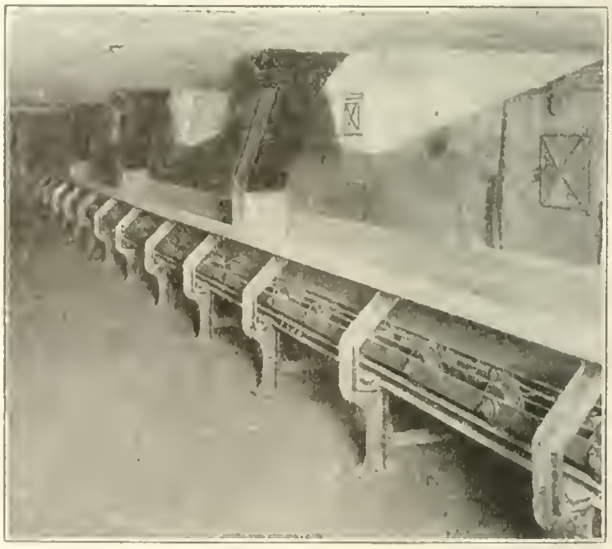
Overhead Bunkers and Traveling Weigh Hoppers for Delivering Coal From Any Bin to Any Stoker.

The coal bunkers are constructed of steel, reinforced concrete and are integral with the building itself. The hoppered bottoms are fitted with double undercut gates—overhead, in the boiler room—and by using traveling weigh hoppers, the coal may be drawn from any of the bunkers, and conveyed to the stoker before any of the boilers.



Top Run Above the Bunkers.

Coal is received from trucks, or cars, and dumped through gratings into a chute which carries it to the weighing hopper, placed beneath the alley or street level. After being weighed the coal is delivered by means of an electrically driven feeder, to the buckets of the carrier system which passes beneath. Close to the side wall, immediately beyond the weighing hopper, the carrier system turns upward until it is close to the ground floor of the building, where it makes another turn for the upper horizontal run over the coal bunkers. Placed on the lower rails of the carrier system is a traveling tripper, which is actuated by wire ropes, the latter being controlled by means of a hand winch conveniently located near the scale beam on the receiving floor. By means of this mechanism the tripper can be so placed that coal may be dumped into any bunker selected. After traveling across the bunker tops, the bucket carriers pass over a sprocket wheel and begin their descent to the ash level in the fourth basement, where the lower horizontal run passes the ash pits of all the boilers, and ultimately reaches the weigh hopper where the circuit started. Offset steel spouts are provided to return to the carrier any coal which may have spilled en route.



Lower Run of the Carrier, Showing Ash Hoppers.

Ashes and small cinders are discharged by means of chain grates into the ash pits under the boilers, and from here they are scraped out and transferred to the bucket carriers by means of chutes, wherever the [illegible] coming coal. Conveyed along [illegible] traveling beneath the now inact[illegible] the ash filled buckets follow th[illegible] the upper horizontal run where [illegible] over the ash bunker. At this p[illegible] the bunker to await permanent d[illegible]

The system described in this [illegible] in a city office building and is [illegible] any office building having its own [illegible] The coal is automatically received [illegible] from car to stoker, and the ash[illegible] pit and conveyed to temporary stor[illegible] manner with a minimum of man[illegible] system occupies very little space [illegible] It is cleanly in both loading and [illegible] the buckets being bridged to prevent [illegible] either coal or ashes, and eliminating the p[illegible] of droppings when the bucket edges separate to turn from horizontal to vertical runs or vice versa.

[illegible]

NEW SPREADER PLOW CONSTRUCTS EMBANKMENTS WITHOUT USE OF TRESTLES

During the past year a new spreader plow was brought out by the Bucyrus Co., South Milwaukee, Wis. This plow has a weight of about 68 tons, 60 per cent of which is in specially annealed steel castings. One of its unique features is the ability to vary the width of spread of the wings automatically with no loss of time. In addition the wings may be opened or closed irrespective of their inclination. The plow will operate effectively with an ordinary train pressure of 70 lb. of air, and has performed successfully on as low a pressure as 50 lb. Its operation is entirely automatic, only one man being required to operate.

The following description of the construction of a 7-ft. high bank with a top width of 10½ ft., alongside the working track on the Hull Rust dumps of the Oliver Iron Mining Co. of Hibbing, Minn., will show how this new spreader operates.

The materials encountered on the Hull-Rust dumps consisted in the main of heavy gravel with a generous sprinkling of boulders. A fairly level stretch was selected and the track laid in sections, with the joints broken evenly, in order to facilitate handling. These sections were unloaded from a flat car with a locomotive crane which spotted the sections ahead, these sections being bolted up as fast as laid. This track was made as level as possible by blocking up temporarily. The first procedure varied somewhat with the character of material encountered. Where this material contained considerable boulders the load from the first dump was spread level with the top of the rail, thus building a 21-in. embankment. The tracks were then shifted to the top of this newly constructed road bed. It can readily be seen that with the most careful blocking the track contained considerable depressions. The facility with which the above mentioned embankment was made level, was accomplished by raising and lowering the wing as the material was spread, thus assuring an even grade.

When the material ran even and no large boulders were encountered, the first procedure was to plow 12 in. below the bottom of the tie attaining this depth in successive cuts. This provided space in which to dump material, thus eliminating the tendency of the material to flow back on the rails when dumped from the cars.

When this 24-in. embankment was completed, material was dumped to the far side in order to anchor the track. This [illegible]

Diagram Showing One Method of Building a [illegible]-Ft. Embankment in Four [illegible]-Ft. Lifts

the wing horizontal on the level with the rock fixed at a minimum [illegible] of 12 ft. from the center of the track. The second step was to plow the same material with the wing fixed at 16 ft. width of spread, and then at the maximum or 22½ ft. width of spread. These operations were repeated three times, making a total of nine operations on this dumping. The same steps were taken each time except that the maximum width was reduced each time to 2[illegible] ft. or to 20½, 18 and 16 ft. respectively, each time gradually lowering the wing horizontally until the maximum depth had been reached or 2 ft. below the top of the rail. The purpose of decreasing the width each time was to raise the material higher and to lessen the side thrust on the rail and the power required to push the plow, and, furthermore, to attain the object of throwing the material beyond the reach of the wing. The object of feeding down was, as stated before, to provide dumping area.

The base of the material was now 16 ft. from the center of the track. The wing was then raised horizontally to 19 in. above the top of the rail and the same dumping was plowed at the maximum width of 22½ ft. The purpose of this procedure was to carry the ridge over as far as possible and to build a shoulder at this width. It will be seen that this one dumping was plowed ten times.

Then more material was dumped in the space provided and this was plowed with the wing horizontal. This is repeated until a maximum depth of 24 in. and a 12-ft. width was attained.

The wing was then raised to the maximum of 19 in. above the track level and the material was thrown over as described before.

At this juncture, a bank had been constructed 3½ ft. in height, above the top of the rail.

The tip of the wing was then raised to the maximum of 7 ft. above the inner end. This consumed about 15 minutes. More material was then dumped and plowed. The plowing was first done with the wing at this inclination at a minimum width of spread. This width of spread was increased in three steps or to 12, 16, and 22½ ft., gradually lowering the wing each time, down to the maximum depth, maintaining the same angle of inclination.

This was repeated as often as necessary or until the material lay in a line from the inner point of the wing, 2 ft. below

Bucyrus Spreader Plow, Plowing 16 Ft. From the Center of the Track 24 In. Below Top of Rail on the Dumps of the Oliver Iron Mining Co., Hibbing, Minn.

the top of the rail, to the tip of the wing at 22½ ft. from the center of the track. This again provided dumping space for a new load which was then dumped.

The wing was then raised, maintaining the same inclination, until its inner end was level with the top of the track. The material was plowed as before in steps of 12, 16 and 22½ ft., feeding down each time (with the wing at the minimum width of spread), as before described, in order to provide dumping space for the next load.

More material was now dumped and the same procedure was repeated each time changing the slope of the bank by bringing in the tip of the wing 1 ft. This added successive wedge-shaped slices to the embankment. This procedure was repeated until the minimum width of spread was reached, or 12 ft.

The embankment by this time had attained a height of 7 ft. with a top width of 10½ ft., this last dimension being the difference between maximum and minimum width of spread with the wing at the maximum inclination.

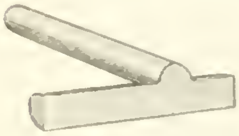
If it is desired to raise this embankment to a still higher elevation, the tracks may be lifted by a locomotive crane, section by section, and placed on this new embankment, and the above procedure repeated as often as necessary, as shown in the accompanying sketch.

It must be remembered that the procedure here described is that followed on the spoil dump of the Hull-Rust Mine at Hibbing, Minn., but it may readily be seen that conditions encountered elsewhere might alter the method employed in small details. For instance, if boulders were not encountered, the whole procedure would be considerably simplified. It was found that large boulders could be easily plowed and elevated if the wing encountered this boulder below its center. To illustrate this, attention is called to large boulders in the embankments shown in some of our accompanying views.

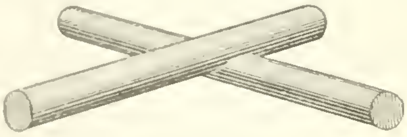
The speed maintained in plowing usually averaged from 7 to 10 miles per hour in ordinary material.

A WELDED WIRE FABRIC FOR CONCRETE ROAD REINFORCEMENT

A fabric designed and manufactured exclusively for use in the reinforcement of concrete roads is being made by the National Steel Fabric Co., Pittsburgh, Pa. It is claimed that this fabric is 30 per cent stronger than hot rolled bars of equal size and that it provides the greatest amount of strength for a given amount of steel, and, at the same time minimizes the cost of transportation, handling and placing the reinforcement in the road. All intersections of the fabric are welded together, as shown in the accompanying cuts. The fabric can be successfully shipped in rolls and economically handled and straightened in the field.



Section at the Weld.

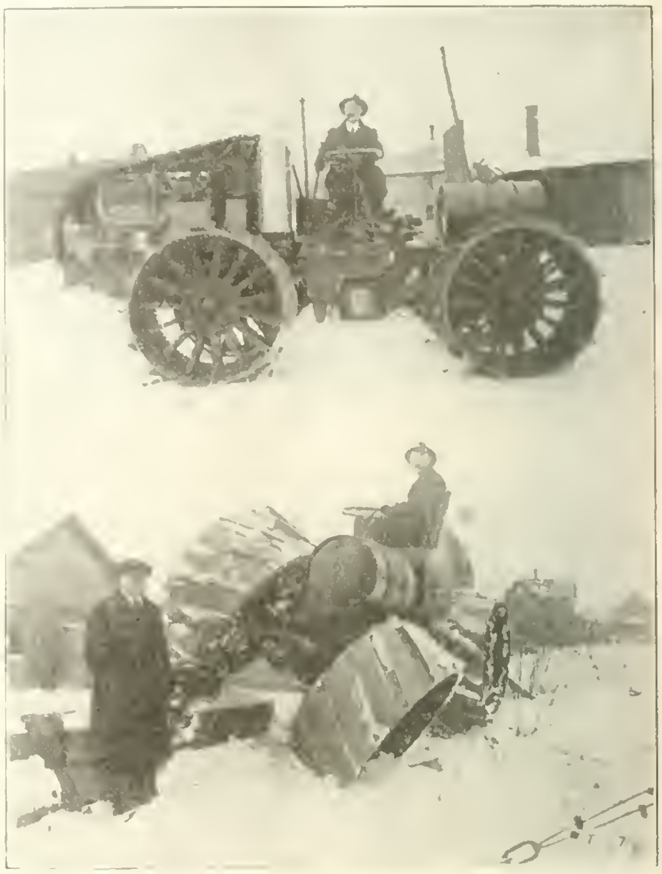


Welded Bond of Intersecting Wires, Without Excess Metal.

Roll of National Board Fabric and Method of Handling.

A 4-WHEEL DRIVE TRACTOR

A new tractor having a unique four-wheel drive principle has been brought out by the Rogers Tractor & Trailor Co., Albion, Pa. One of the illustrations shows the flexibility of this machine. It is claimed that any one of the four wheels can be raised 5 ft. off the ground without throwing any gears out of alignment or causing any friction, the four wheels being independent of each other. The front wheels can be tipped at one angle and the rear wheels at the opposite angle, for the frame is in two separate parts, front and rear, but hinged to permit oscillation. The Rogers will turn in a 16½-ft. radius, but having the same speed and power in backing as going forward, it can back out of a narrow space with or without turning. In tests the machine has climbed over a wall 6 ft. high at a 68-degree angle. The motor is a 4-cylinder gasoline 6¾-in. bore, 9-in. stroke, made by the Buffalo Gasoline Motor Company, Buffalo, 98 h.p., 850 r.p.m., multiple disc clutch especially designed with sliding gear transmission designed and constructed by the Rogers Company with two speeds forward and two speeds reverse permitting same speed ahead or backwards. The power is delivered to the drive wheels without the use of a single universal joint and with a minimum loss due to the absence of complicated mechanism. The power is augmented by the weight, 15,000 lb., and four wheels 48 in. in diameter, 24-in. face, equipped with 15 lugs 3x3x7-16. There are two differentials of Rogers design and construction. The power is delivered to the four drive wheels by bull pinions. All gears are special high grade machine cut steel and are enclosed and running in a bath of oil.



Rogers Four Wheel Drive Tractor in Action.

A 3-WHEEL POWER VEHICLE FOR HAULING CONSTRUCTION MATERIAL

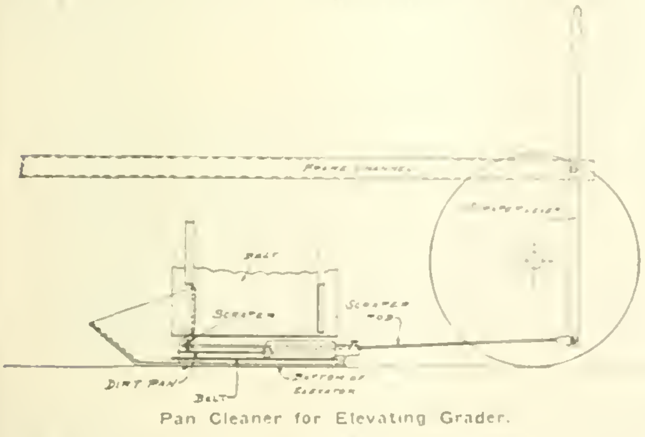
One of the many labor-saving machines which was developed as a result of the high cost of labor during the past year was the Clark Tructractor. The tructractor is similar to a motor truck in operation and construction, though much smaller in size and quite different in design. It has a capacity of 1 cu. yd. of dry mix or 18 cu. ft. of wet mix which is carried in an all metal hopper body which automatically "spots" and dumps its load in any desired place. It is used for hauling wet mix directly from the semi-portable central mixing plant to the roadway, or dry mix from the storage piles to the mouth of the portable mixer without rehandling. It is equipped with wide-faced steel wheels to prevent cutting up the finished subgrade. Besides being used for road building, one model of the tructractor is being used for hauling materials used in the construction and excavation of building foundations. Several of these machines have been used on the new Union Station job, Chicago, hauling concrete aggregate from the mixer to the forms for the retaining walls of the

Clark Trucktractor on Union Station Job, Chicago.

foundation. All this material was hauled a distance of about 250 ft., then up an incline to an elevation 20 degrees above grade—in other words about 28 per cent incline. The Tructractor is propelled by a standard four-cylinder engine, 25 h.p., operating at speeds varying from ½ to 12 miles per hour. The engine is located over the single rear wheel. Gasoline is supplied from a 5-gal. welded steel fuel tank under the hood. The machine is constructed of metal throughout. Three wheels are used instead of the usual four in order to get a shorter turning radius, the load being carried over the two front driving wheels, in front of the operator, while the single rear wheel is used for steering. In the automatic dump body model the driver controls the dumping and operates the machine without leaving his seat with the load always in front of him.

DIRT-PAN CLEANER FOR ELEVATING GRADER

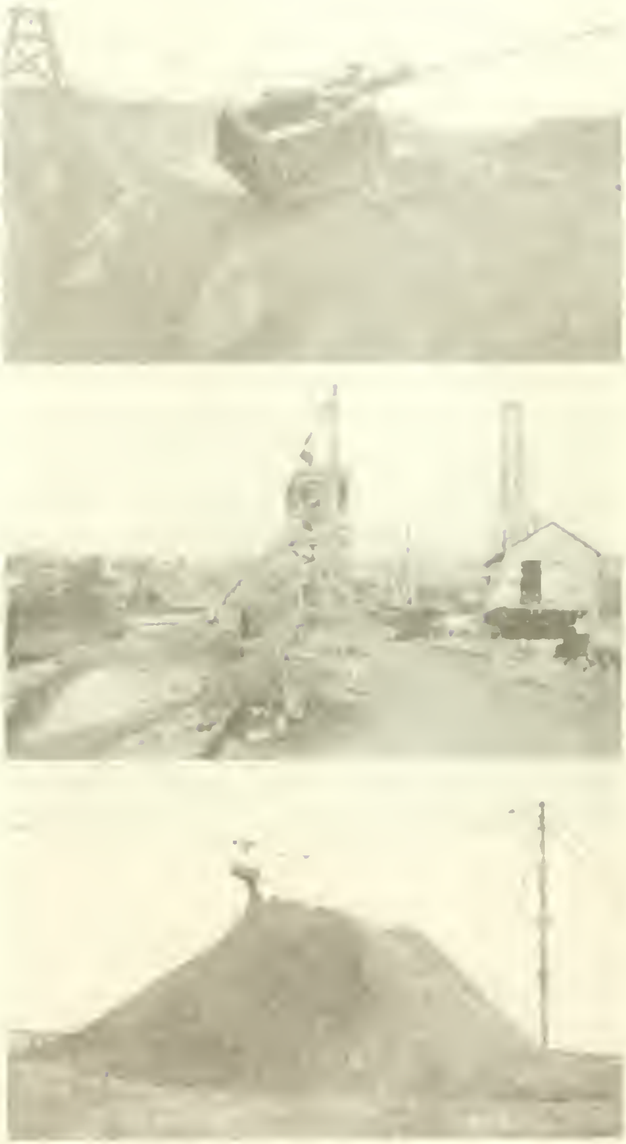
Machine operators will appreciate a new device for cleaning the dirt pan on an elevating grader brought out this season by the Western Wheeled Scraper Co., Aurora, Ill. Heretofore it has been necessary to stop and dismount frequently, in order that the dirt pan could be cleaned with a stick through the "cat-hole," to keep the belt from clogging. The loss of time resulting has greatly restricted the yardage moved. Western machines now are provided with a simple mechanical device for freeing the pan from dirt without stopping the machine. This appartus is operated by a lever from the platform.



Pan Cleaner for Elevating Grader.

NEW USES FOR DRAGLINE CABLEWAY EXCAVATORS IN DIRT MOVING FIELD

Engineers and contractors [illegible] with interest on the progress made in adapting dragline cableway excavators to general excavating [illegible] during the past year. This type of equipment, which [illegible] used for a long time by commercial gravel plants for digging and conveying sand and gravel, is only beginning to be [illegible] for other dirt moving operations to which it is equally well suited. Typical of the enlargement of the field of usefulness of this equipment during 1929 are the following [illegible]. An eastern contractor had a problem of excavating material for three fills for bridge [illegible] and approaches [illegible], N. Y. The contract specified that material shall be taken from the river only [illegible] [illegible]. An [illegible] span [illegible] Sauerman [illegible] excavator set up at a point on the main approach for the bridge solved the problem and the entire 60,000 cu. yd. of material for the three fills was obtained from the river by the use of the one machine. A zinc company wished to dig a 270x320-ft. reservoir for coal storage. A 700-ft. span 1½ cu. yd. Sauerman dragline cableway excavator handled the work successfully and distributed the spoil over a small area incidentally eliminating the necessity of a trestle and auxiliary conveying equipment. Later it is probable the dragline cableway excavator will be used for reclaiming the coal from this storage reservoir. On a dam job in Illinois it was necessary to make use of the gravel in the stream as aggregate for the



Upper and Lower Views Show a Sauerman Dragline Cableway Excavator Excavating a Storage Reservoir. Middle View Shows Another Installation of This Same Type of Excavator Used to Widen a River and Dig Gravel for a Concrete Dam Across River.

concrete. The entire project called for the widening of the river from its normal width of approximately [illegible] ft. to a width of 1,000 ft., thus making a storage basin for water to supply the city's water plant. A Sauerman [illegible] cableway excavator which had been purchased by the contractor with the intention of using it only for digging the gravel was also called into service for shaping up the reservoir excavation. The specifications called for the excavation to be bowl-shaped, and the cableway very successfully finished the reservoir to that shape and was then used for excavating the sand and gravel from the stream to furnish the aggregate for the construction of the dam.

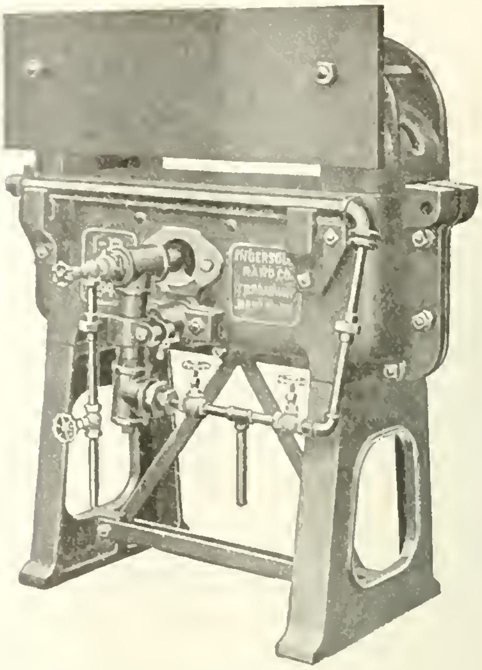
NEW FULL CIRCLE REVOLVING CRANE

A crane of the full circle revolving type has been brought out by the John F. Byers Machine Co., Ravenna, O. The machine is equipped with differential in drive for road wheels or apron tread. The Apron tread traction is the Byers standard using [illegible] complete units. The road wheel machine may be converted into an apron tread traction by the owner in the field. The railroad type crane drives all four wheels and is equipped with a coupler bar for switching cars and is capable of attaining ten miles per hour traveling speed. Outriggers can be furnished for the railroad crane when desired. The steam machine is equipped with 12-in. Butt strap, A. S. M. E. boiler and 7 in. by 7 in. Byers high duty, horizontal, barrel guide, non-reversing hoisting engines. The gasoline machines are equipped with 15 h.p., 4-cylinder engines, especially designed for this class of service. The electric machines are equipped with approximately 40 h.p. motor, depending somewhat upon the kind of current available. Swinging is accomplished either by swinging clutches or additional engine (on steam crane only), as desired. The clutches for swinging are the same type as the hoist and boom, and are of proven efficiency. The swinging engine is a twin cylinder, steam reverse, high speed type suitable for this service. The tagline mechanism for preventing bucket from twisting is an automatic drum, which operates independently of the angle of the boom, and is therefore as useful with a low boom as with a high one. One piece steel casting center arrangement which is the heart of the crane insures a permanent, secure fastening at this point. The crane may be equipped with generating unit and 36-in. magnet for handling scrap, the 12-in. boiler permitting the installation of the generating unit. Its capacity is based on handling ¾-yd. bucket in sand at 30 ft. radius or equivalent to 5,200 lb. at that radius. Hoisting capacity at 12 ft. radius, 5 tons. These capacities are based on road wheel crane and are somewhat greater in apron tread equipment and correspondingly less on railroad wheels, depending on gage of track. They are calculated, also, upon crane being equipped with 30-ft. structural boom. Any required length of boom can be furnished up to the length at which the weight becomes prohibitive, the crane capacity, of course, being correspondingly reduced in proportion to the additional weight of boom.

New Byers Full Circle Revolving Crane.

OIL FURNACE FOR HEATING DRILL STEEL.

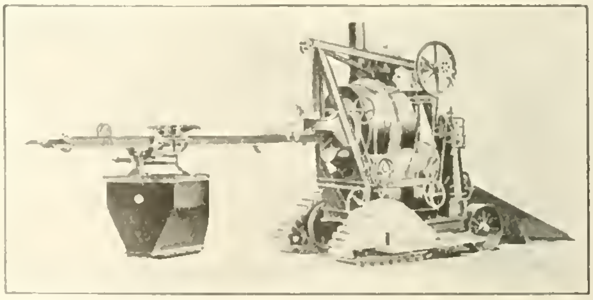
An oil furnace designed to quickly and evenly heat drill steel is illustrated. It is claimed this furnace will heat steel fast enough to meet the full capacity of one or two drill sharpening machines—1,600 to 2,400 pieces per 8-hour shift. The installation is very simple—no foundation being required. To put the furnace in operation it is only necessary to connect this self-contained machine to the oil and air supply. The floor space required is 3 ft. by 4 ft. plus the necessary room to accommodate length of steels to be heated. This furnace is known as the I-R No. 24 Furnace. It is made by the Ingersoll-Rand Co., New York.



Furnace for Heating Drill Steel.

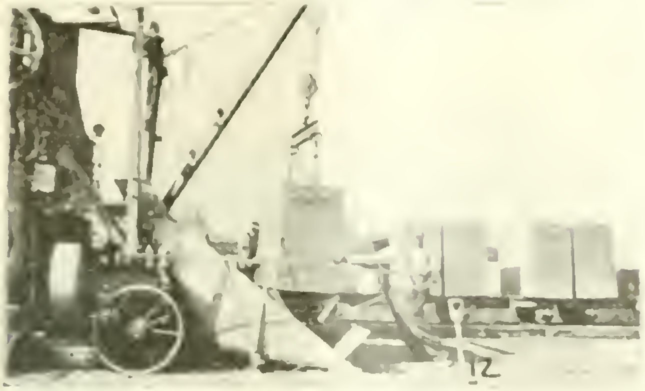
IMPROVEMENT IN SMITH SIMPLEX PAVING MIXER

Several improvements have been made this year in the Smith simplex paving mixer, manufactured by the T. L. Smith Co., Chicago. Among them are a new, extremely steep angled skip, working on a double supporting pivot. The skip end has been designed so that it can be made closed end or open end in a few minutes, on the job. A powerful differential brake also has been perfected for the main hoist. Some very good improvements have likewise been developed on the band friction for the propelling gears. The bevel gears, which constitute the reverse mechanism, are made of high carbon steel and both bushings in the gears and the bearings on the gear shaft are the best grade of phosphor bronze. All the rest of the gears throughout the paver are cast steel and the main driving gears have cut teeth. The Smith Derrick Attachment for pavers has been improved very remakably. This new derrick is supported entirely from the frame of the paver without wheels or any additional support. It has a ball bearing foot block, is easily sung, raises and lowers automatically with the skip as it lowers and raises, respectively, and is safe, strong and dependable in every detail.


Smith Simplex Paving Mixer.

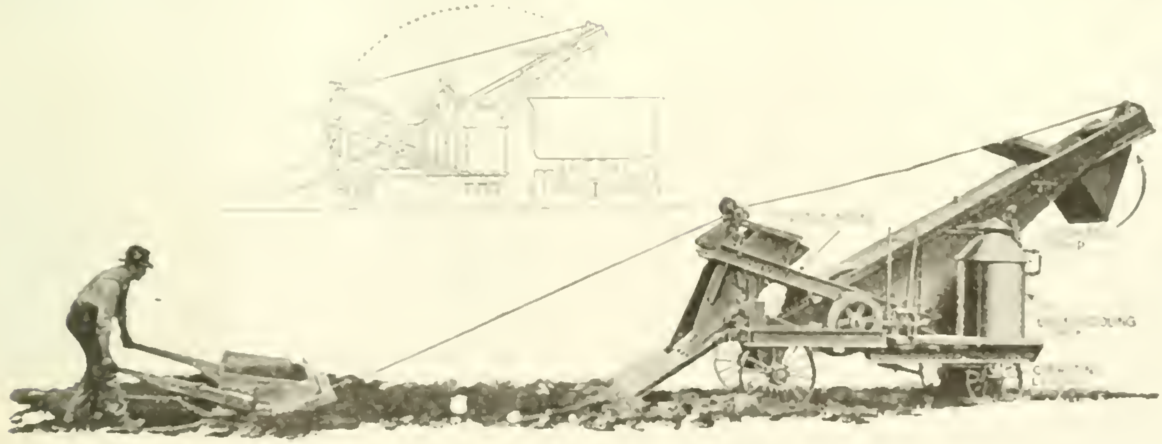
BATCH BOXES AND RAILWAY TRUCKS

The accompanying illustration shows the new Western batch boxes and road builders' trucks. The batch boxes are built of steel or oak, of approximately 1 cu. yd. capacity, provided with two or three compartments for separating the measured material, as desired. The Western road builders' truck was designed for carrying the batch boxes, one or two, according to size, fitting on each truck. It is built strong, 24-in. gage, with drawbar springs, journal springs and roller bearings. It is readily convertible into a V-shaped dump car for road work, by attachment of the proper supports and body. The Western road builders' service car, capacity 6 tons, 24-in. gage, is built for carrying industrial track sections; portable track and switches also are furnished when desired.


Charging Mixer From Western Batch Box

NEW EXCAVATING AND LOADING MACHINE

A new portable excavator and loader of the drag line was brought out this year by the T. L. Smith Co., Milwaukee, Wis. Only two men are necessary for the operation of this machine, one at the operating levers and one at the loading point. At a point anywhere within 50 to 200 ft. from the machine is stretched a chain, at right angles to the line of digging. Upon this chain are two sheaves, hooked to the chain; either sheave may be unhooked and re-located in an instant. One heavy cable passes from the hoist drum on the machine, then to the digging skip, then through both sheaves, back to the retrieving hoist drum on the machine. The operator at the machine manipulates but two levers and a foot brake. As he places power on the digging line, the other man manipulates the handles on the slip, so as to fill it with the material to be dug or removed. The slip has a capacity of 15 cu. ft. per trip. As soon as the slip is filled, the man releases the handles and allows the slip to ride to the excavator. As the slip strikes the apron at the machine it unlocks the catch of the pivot arm on the machine. The arm then carries the slip up over the machine and onto a slanting chute located on the front of the machine from where the material in the slip discharges into the waiting wagon, truck or railroad car. The slip is then quickly retrieved to the starting point and the operation repeated.


New Model K Excavator and Loader.

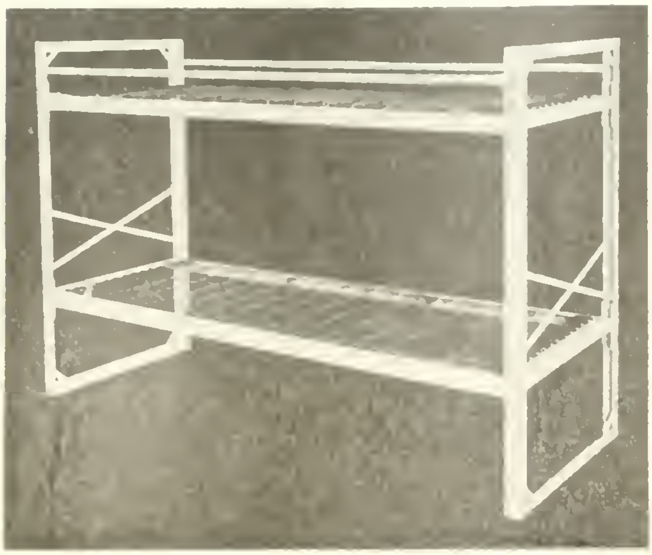
NEW TRUCK DUMP BODY HAS SQUARE CORNERS.

The accompanying illustration shows a 5-ton Gramm-Bernstein truck equipped with a new dump body. This body is of heavy gauge steel [illegible] construction and is a departure from the ordinary dump body in that it has square corners instead of round cornered. This not only permits of a stauncher construction but in addition permits the loading of bricks, cement blocks, etc., without liability of damage from breaking. The tail gate is double acting hinging either from the top or bottom as desired. The body is dumped by a hydraulic hoist which is operated by a geared power take-off from the transmission on which B. A. Gramm holds basic patent rights. The hoist is in a vertical position instead of tilting, thus saving space at the same time having an equally high dumping angle as the tilted hoist.

5 Ton Gramm-Bernstein Truck with New Dump Body

THE METAL BUNK FOR CONSTRUCTION CAMPS

The portable metal bunk for contractor's use was developed primarily to satisfy sanitary requirements. Yet it was not long before contractors came to realize that the sanitary feature not only accomplished practical results by complying with various laws and city ordinances and by making happier, more contented workmen, but that metal bunks made an economical bunkhouse system. The recent development of the portable metal house for various construction purposes has made further demands for metal bunks. A portable metal house logically calls for a portable metal bunk. Having all portable equipment makes it easy to erect and easy to knock down and move from place to place. It also eliminates the matter of fire hazard and disease. By the use of this combination of metal equipment, the contractor is able to have great mobility of equipment and also a permanent investment. The old-style wooden bunks were always charged up as expense. When the job was completed they represented merely so much old lumber. Under the modern plan, metal bunks are a standard part of the contractor's equipment and are not only moved from place to place on the same [illegible], when the job is finished, are stored away with concrete mixers, drills, wheelbarrows and other equipment that are becoming a permanent part of the contractor's standard [illegible]. With the earlier portable metal bunks this was almost an impossibility. Bunks made with the angle braces and bolted supports were often of limited life. The rough handling received in shipment and setting up and knocking down soon resulted in bent, broken and distorted outfits. However, with a bunk of the type of the Romelink "99," as manufactured by the Southern-Rome Co., all cross braces and corner braces are done away with and there is no chance of sagging or distortion, breakage or bending. The double button locking systsem made possible a more secure, rigid bunk, easier handled and less subject to wear and tear of camp use. These bunks can be set up and taken down time after time, and are always in good condition for the next job.



Romelink "99" Bunk.

DRILL STEEL SHARPENING MACHINE.

A new drill steel sharpening machine was brought out by the Ingersoll-Rand Co., New York. This sharpener was designed primarily to rapidly and exactly sharpen and shank drill steel such as: cruciform steel up to 2 in. in diameter or round, hexagon, octagon, quarter-octagon, auger or spiral steel up to 1⅞ in. in diameter. However, it has performed so many other tasks that "Drill Steel Sharpener" is almost a misnomer. When fitted with special devices, it will forge boltheads, pins, stanchions, etc.; in fact, nearly 200 different products have been made by this machine. The single lever, which controls all of the operation, of the machine, is fitted up with a safety locking device. The throttle valve is of the balanced spool type, operates easily and quickly, is positivo and instantaneous in its action. The hammer cylinder is an improved valveless type of hammer drill cylinder. This construction permits the free moving hammer to deliver exceedingly fast and powerful blows against the end of the dolly upsetting the steel and so forming the bits and shanks with extreme rapidity. The base has sufficient strength to withstand the severe strains and shocks met with in everyday work. It needs absolutely no foundation with the exception of a few planks to level it properly and is not even bolted rigidly to them. Efficient and positive lubrication is provided for the entire machine by the "Heartbeat" lubricator. This is embodied in the throttle valve chest casting and works automatically whenever the machine is in action. It is provided with adjustment for regulating the quantity of oil desired.

Leyner-Ingersoll Sharpener.

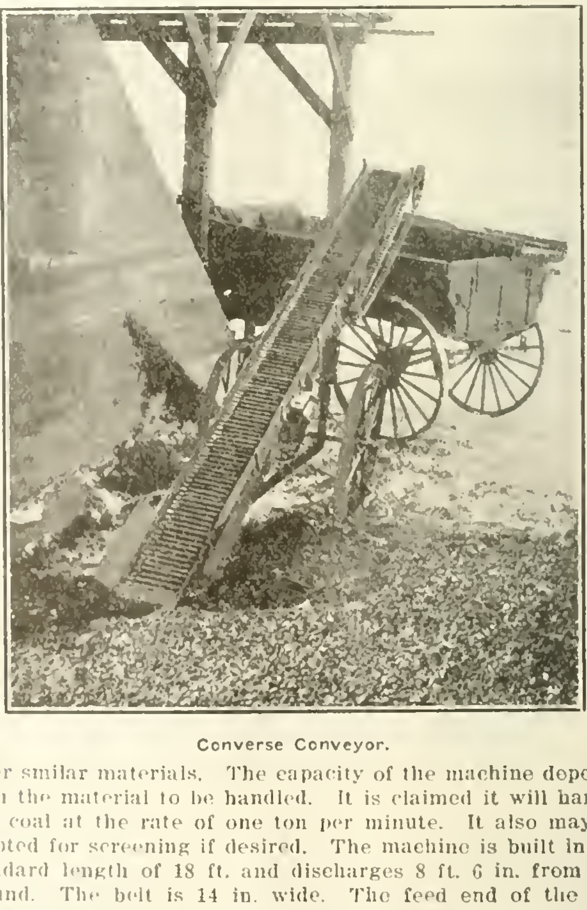
TWO NEW WESTERN AIR DUMP CARS

Two new Western air dump cars of 25-yd. and 45-yd. capacity respectively have been added to the line of the Western Wheeled Scraper Co., Aurora, Ill. The 25-yd. car was designed to meet certain conditions at the copper mines of the southwest, where large capacity was required in a car short enough to dump low-grade ore into established bins. Its length is the same as that of the Western 20-yd. car and the trucks are of 100,000 lb. capacity. The 45-yd. car is a Western 30-yd. car, built up to greater capacity with side-boards. It was designed for handling coal and is equally practical for any material of large bulk and comparatively light weight.

45-Yd. Western Air Dump Car.

A NEW "STEEL BELT" CONVEYOR.

A conveyor, the outstanding feature of which is a steel belt, has been placed in production by F. S. Converse Co., Inc., Johnson City, N. Y. The belt is made of galvanized sheet steel and consists of a series of steel cleats riveted to detachable link chain, making the belt entirely flexible. The conveyor will handle all kinds of coal, also sand, gravel, crushed stone, ashes, coke, small boxes, castings and many other smilar materials. The capacity of the machine depends upon the material to be handled. It is claimed it will handle soft coal at the rate of one ton per minute. It also may be adapted for screening if desired. The machine is built in the standard length of 18 ft. and discharges 8 ft. 6 in. from the ground. The belt is 14 in. wide. The feed end of the machine is near enought to the ground so that the material to be handled does not have to be lifted on to the belt—the material is simply "scraped" to the feed end of the machine.



Converse Conveyor.

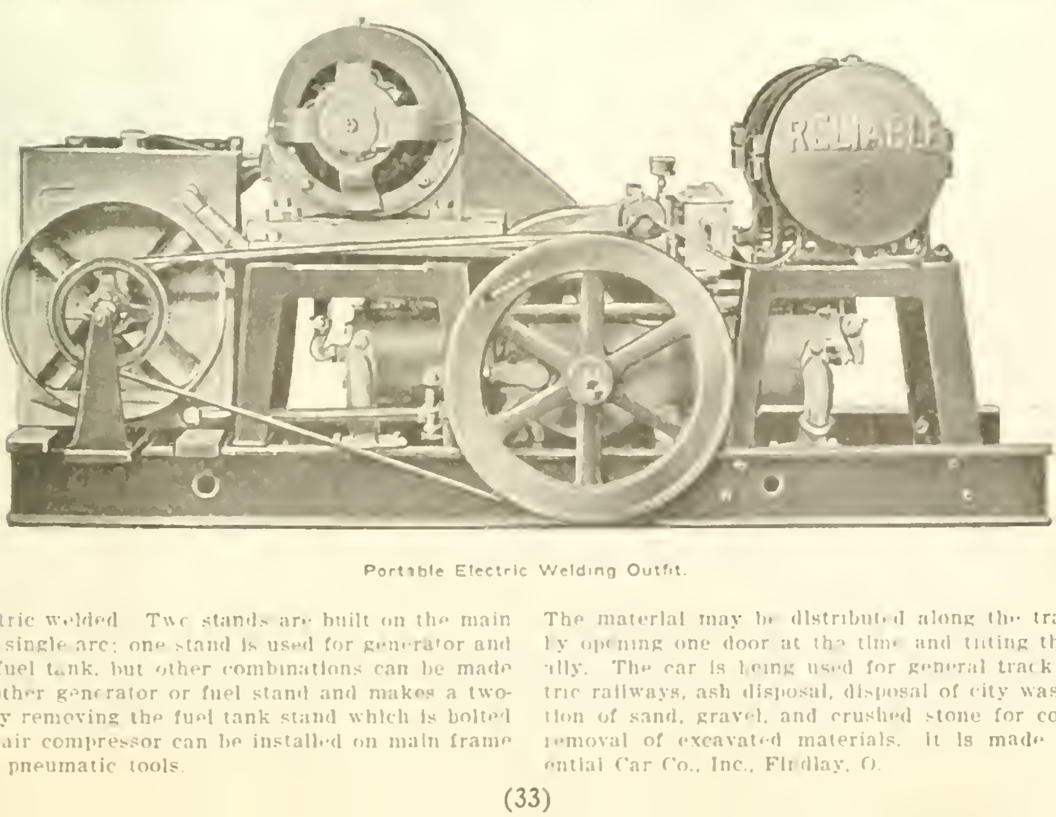
NEW 30 BEST TRACTOR

A 20-30 h.p. model of practically the same design as its 60 Tracklayer tractor has been perfected by the C. L. Best Gas Traction Co., San Leandro, Calif. The new model has a length (not including seat) of 9 ft. [illegible] in., and a height of 79 in. to top of radiator. It weighs [illegible] lb. and has a speed of 3 1/16 miles per hour on high, [illegible] miles on low, and $2\frac{1}{2}$ miles on reverse. The track is special [illegible] steel with "Best" rocker joint link connection, link and [illegible] and cast integral. Track centers are $41\frac{3}{4}$ in., and length of track on ground is [illegible] in. The shoes are $11\frac{1}{2}$ in. The motor is a "Best" 4-cycle 4-cylinder, water cooled, valve intake type. All working parts, though entirely enclosed, are easily accessible. The tractor turns in its own length.

New Model Best Tracklayer Tractor

SELF-CONTAINED ELECTRIC WELDING OUTFIT.

A self-contained electric welding outfit, one or two arc units, driven by silent chain and using a 20-HP. two cylinder opposed heavy duty oil engine, has been brought out by the Reliable Tractor & Engine Co., Portsmouth, O. The outfit can be transported on a 1-ton truck, and operated from the truck if necessary, or transported through a doorway as it is only [illegible] in. long, $4\frac{1}{2}$ ft. high and 44 in. wide, or a special width of $37\frac{1}{2}$ in. when specified on single arc unit. The main structure of the frame is 7 in. steel channels reinforced by braces electric welded. Two stands are built on the main channel in the single arc; one stand is used for generator and the other for fuel tank, but other combinations can be made by placing another generator or fuel stand and makes a two-arc outfit, or by removing the fuel tank stand which is bolted to frame. An air compressor can be installed on main frame for the use of pneumatic tools.



Portable Electric Welding Outfit.

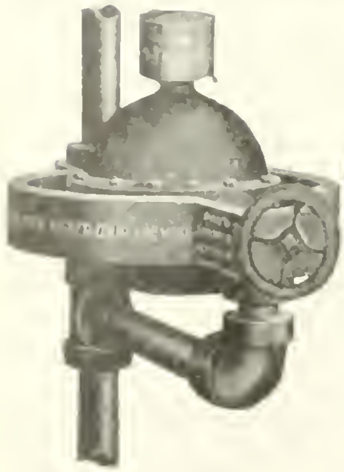
DUMP CAR FOR ELECTRIC RAILWAY SERVICE

A two-way tilting body car designed specially for handling loose material on [illegible] railways, is illustrated. [illegible] car the [illegible] center of gravity and clear dumping is effected by tilting the body a little or traversing movement on the underframe, to either side, and then tilting it in such a manner that the body is automatically balanced, and under control, in all positions. The traversing and tilting mechanism is electrically operated by a small motor, which is automatically controlled through a reversing switch. The tilting body is divided into three compartments, each with its own side doors, so that different kinds of material may be hauled at the same time. The contents of the compartments, or a part of each compartment, may be discharged at different points, or the entire load discharged automatically at once. The material may be distributed along the track as desired by opening one door at the time and tilting the body gradually. The car is being used for general track work on electric railways, ash disposal, disposal of city waste, transportation of sand, gravel, and crushed stone for contractors, and removal of excavated materials. It is made by the Differential Car Co., Inc., Findlay, O.

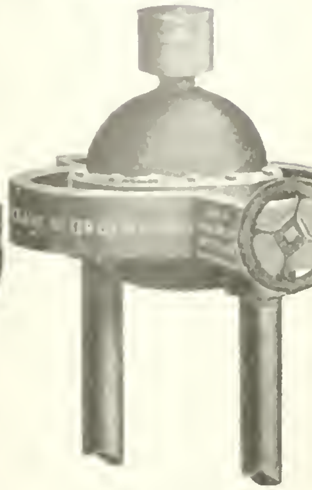
Two-Way Tilting Body Car.

METER COUPLING YOKE

A [illegible] coupling [illegible] has been brought out by the H. W. Clark Co., Mattoon, Ill. It is [illegible] of heavy [illegible] fitted with [illegible]. The water ways are tested to [illegible] working pressure. A [illegible] for [illegible] and bronze [illegible] corrosion [illegible]. The water ways are larger [illegible] area than [illegible] in. pipe supply, [illegible] additional losses of heads [illegible] demonstrated by actual tests, thus insuring maximum deliveries. The yoke is adapted to all ⅝-in., ⅝x¾-in., and ¾-in. meters of every manufacture. It is furnished in 1-in. size for meter box installation only.



Meter Box Coupling Yoke.



Basement Coupling Yoke.

NEW RADIAL TYPE LOADER FOR HANDLING LOOSE MATERIALS

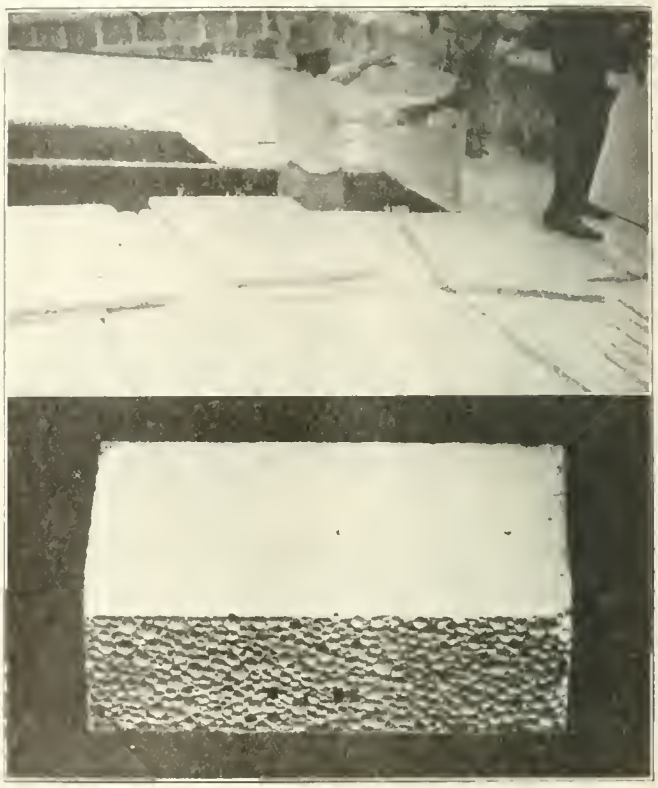
A new design for loading machine, especially adapted for handling crushed stone, gravel, sand, etc., was brought out by the Jeffrey Manufacturing Co., Columbus, O. The 3-wheel construction of this loader enables it to move backward and forward along straight lines into a pile of material or to cut wide swaths across the face of a pile by swinging alternately upon its driving wheels as pivots, which action is obtained through the use in its driving unit of a set of differential gears, the same as in an automobile, whereby the driving wheels act in conjunction with or independently of each other.

By turning the steering wheel at quite an acute angle to the driving wheels, the discharge chute will remain practically stationary at the center of the circle while the pick-up end of the extending elevator boom will travel in a circular path; or by alternately reversing the propelling drive, the loader will oscillate back and forth in an arc. If the steering wheel is gradually turned through a few degrees either way from the above circular path, the whole machine, while cutting from right to left in an arc, will gradually move forward into the pile, allowing full range of the machine. The loader has a fast speed of 60 ft. per minute for traveling from pile to pile and a slow speed of 4 ft. per minute for feeding into the material. Its capacity is stated to be 1 cu. yd. per minute and it will load crushed stone, maximum size pieces, through 2½-in. ring, maximum size coal, 6-in lumps. The loader is equipped with either electric motor or gasoline engine. Skilled labor is not required for its operation and all controlling levers are in plain sight and in easy reach of the operator.

Jeffrey Radial Loader.

A POROUS CONCRETE AND ITS APPLICATION

A porous concrete which weights only about one-third as much as solid concrete has been developed by the Porete Mfg. Co., Newark, N. J. The material is a composition of Portland cement and sand made porous like a sponge by a special process. It is stated to consist of approximately one-third solid matter and two-thirds air holes. It is claimed that this material is condensation preventing and fire resisting and that it is not affected either by water or steam. This porous concrete is known by the trade name "Porete." It is being used for sheathing material for houses, and for roof decks. Porete roofing slabs are made in standard size 24 in. wide by 32 in. long by 1 3/16 in. thick, reinforced with wire netting and designed like a reinforced concrete slab. They are laid on steel channels at 32-in. centers, to which they are fastened with heavy galvanized sheet metal clips. A thin cement grout about 1/16 in. is brushed over them and they are ready for the waterproofing, which may be a ready roofing paper, a built up roof, or slate or tile. Each slab weights 30 lb. and covers 5.33 sq. ft. When covered with 1/16 cement finish, the roof deck weights 7 lb. per square foot. The breaking load with 32-in. free span is stated to be over 300 lb. per square foot and the breaking load before cement finish is applied is over 200 lb. per square foot.



What Porete Looks Like.
Porete Slabs Being Laid on Roof of Plant Celluloid Co., Newark, N. J.

THE D'HUMY MOTORRAMP SYSTEM OF INTER-FLOOR TRANSPORTATION

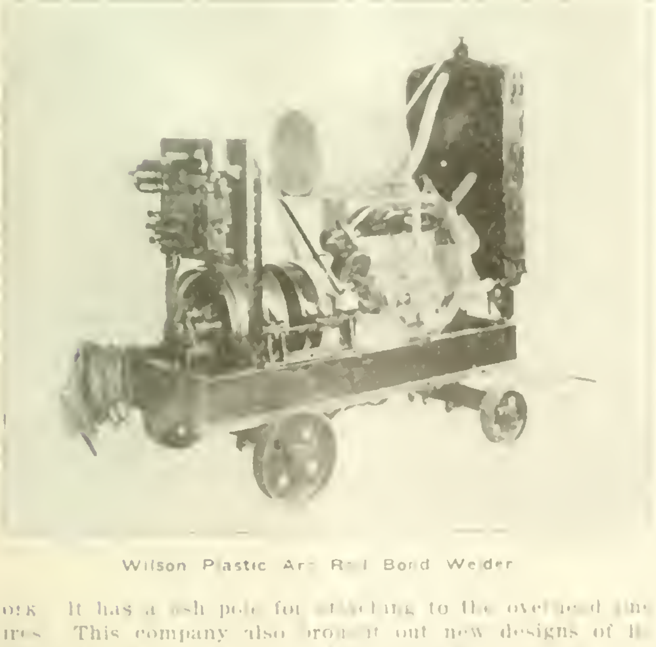
A ramp system of interfloor transportation in multi-story buildings which is claimed to occupy very little more space than elevators is a recent development. The basis of this system is the use of a staggered floor construction which, of course, is a radical departure in building construction. All floors are level and no special types of fittings are necessary, as would be needed in the case of various form of slanting floor buildings that have been suggested from time to time. The economy of the system is stated to lie in the fact that since the floors are staggered, ramps of half the usual length are required for transportation from floor to floor. The conventional method of arranging the system is to place the ramps one over the other so that a vehicle in passing up or down describes the path of a [illegible]. This system is equally applicable to a single or double [illegible]. If separate passages are desired for up and down travel it is merely necessary to place a second helix around the first one. In other words the principle of [illegible] is simply doubled. It is not necessary in doing this to [illegible] as the way [illegible] the space occupied by the [illegible] on the upper helix

Application of Motor Ramp System to Multi Story Building

is greater than that of the [illegible]. This is in marked contrast to the other types of [illegible] wherein the outside helix is much larger in diameter than the inside one. This ramp is known as the [illegible] System. The patents are owned by the Ramp Building Corp., [illegible] Church St., New York City.

OUTFIT FOR WELDING RAIL BONDS

A new [illegible] rail bond welder brought out the past year by the Wilson Welder & Metals Co., Brooklyn, N. Y., is illustrated. This welder can be supplied for voltages from 150-350 volts or [illegible]-750 volts direct current. It is so constructed that it is easily handled by two men and is furnished ready to go to



Wilson Plastic Arc Rail Bond Welder

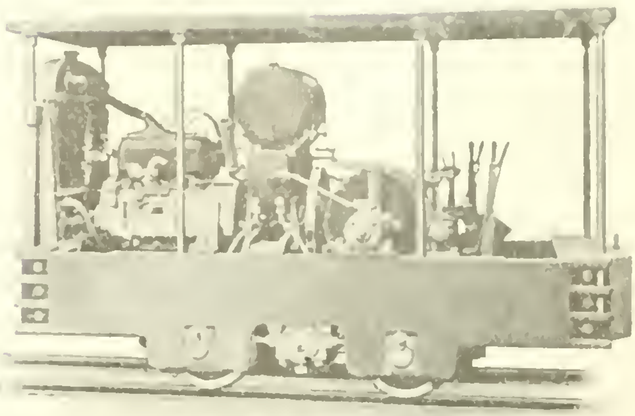
work. It has a ash pole for attaching to the overhead line wires. This company also brought out new designs of its gasoline driven and electric driven welders. The first mentioned is built for both one and two men capacity, two welders being able to work on the same work at the same time without interference. An automatic regulating panel is a part of the equipment and the standard Wilson low voltage direct current generator also is used. A number of these machines [illegible]

SPECIAL TRACTOR ATTACHMENT FOR ROAD GRADER

[illegible]

LOCOMOTIVE FOR ROAD BUILDING OPERATIONS.

A gasoline locomotive designed for narrow gauge transportation systems for road building is illustrated. This locomotive is made in 2½ ton and [illegible] sizes. Its features comprise a [illegible] cylinder gasoline engine, high tension magneto



Lakewood-Burton Locomotive

radiator cooling system and a friction drive, giving any speed from 3 to 10 miles per hour with load, forward or backward, with equal power in both directions. There are no gears to shift, or clutches to get out of order. It is furnished in track gauges of from 18 in. to 56½ in. The low center of gravity makes it particularly desirable for narrow gauge haul over track, which even at best, is always somewhat rough. The [illegible] ton size is the one generally used for highway construction, and negotiates grades as steep as 8 per cent with a good size load. This locomotive is made by the Lakewood Engineering Co., Cleveland, O.

OUTSIDE HANGING SCAFFOLD

An outside hanging scaffold weighing but 13 lb. and occupying none of the working space on the platform is being marketed by the Fischer & Hayes Rope & Steel Co., Chicago. The scaffold is suspended from outriggers or I-beams on specially construction steel wire ropes of high tensile strength. The ropes pass through both boxes of the machines and are held securely by an arrangement of the steel jaws. The machines are joined together on the platform by a wooden putlog or plank of selected fir lumber. They are raised or lowered by means of the lever on the lower box, which is easily done by one workman. All working parts are completely protected from mortar, snow or ice. It can be placed edgewise or broadwise toward the building.

TRACTOR WINCH ATTACHMENT.

A winch attachment which does not [illegible] the traction [illegible] of the tractor, but increases its [illegible] range, has been developed by the Holt Manufacturing Co., Peoria, Ill., with "Caterpillar" tractors. Power is taken from the transmission case in the rear and carried to the winch through a [illegible] and propeller shaft. The final drive is through [illegible] gear and [illegible] gear type [illegible]. The winding drum has a diameter of 8 in. and a capacity for 1,300 ft. of [illegible] in. cable. The speed and power are as follows:

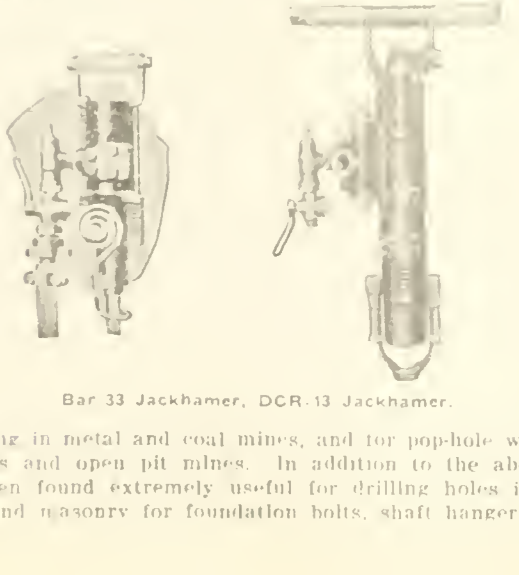
Tractor Equipped with Winch.

	[illegible] speed	[illegible]	Max. reverse speed.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	847
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

The above [illegible] speeds are maximum. By slipping clutch any speed up to maximum can be obtained. Clutch is of ample size to permit slipping indefinitely. The above specifications apply to 5-ton "Caterpillar" tractor.

TWO NEW JACKHAMER DRILLS.

During the past year the Ingersoll Rand Co., New York, completed its "Family of Jackhamers" by the addition of two new drills known as Bar-33 and the DCR-13. The "BAR-33 Jackhamer" weighs 21½ lb. and is only 17½ in. long. It permits the use of a drill in locations and positions not accessible to larger and heavier machines. The field of this Jackhamer is bench work in soft limestone quarries,



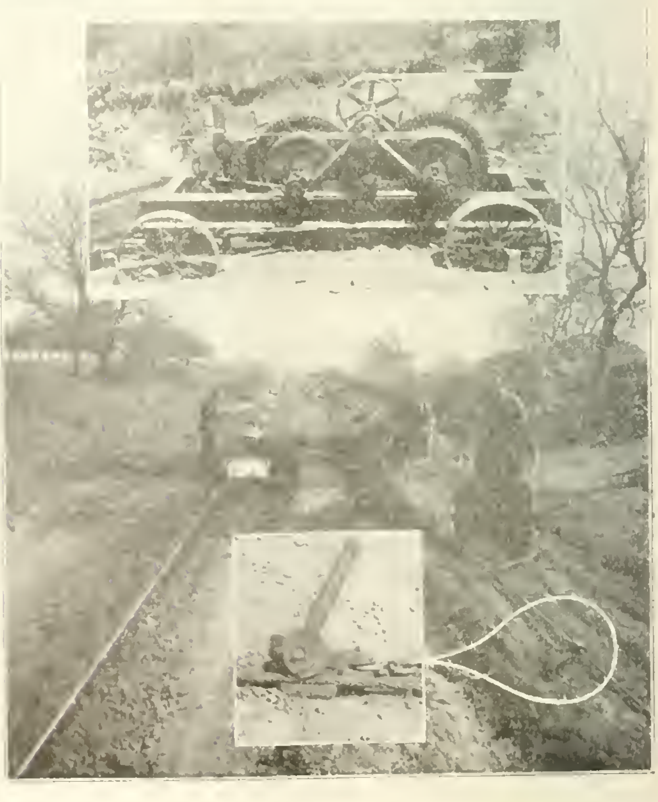
Bar 33 Jackhamer, DCR-13 Jackhamer.

trimming in metal and coal mines, and for pop-hole work in quarries and open pit mines. In addition to the above, it has been found extremely useful for drilling holes in concrete and masonry for foundation bolts, shaft hangers, etc., in industrial plants. The essential construction features of this "Jackhamer" are: All steel construction—steel drop forgings or bar stock being used exclusively and specially heat treated. All bolted construction—nothing to work loose and easy of access. Automatic rotation—very powerful, relieving the operator of this fatiguing part of the work. Spring retained fronthead—takes up shocks that would otherwise fall on the machine. "Butterfly" Valve—assuring positive, effective, and economical operation. Automatic "Heartbeat" Oiler—insures continuous satisfactory lubrication.

The "DCR-13 Jackhamer" weighs 55 lb. It will drill holes up to 12 ft. deep rapidly in hand rock and will fill all the requirements of a medium weight "sinker" or down-hole drill. The field of the "DCR-13 Jackhamer" is shaft sinking, quarrying, road-building, prospecting, developing, etc. In addition to the construction features contained in the "BAR-33 Jackhamer," the "DCR-13 Jackhamer" has: "Spool Butterfly Valve"—retaining all the advantages of the "Butterfly" and still more efficient. "Handy" hole blowing device—very effective in keeping the hole clear and renewable bushing in rotation sleeve.

A NEW DIRT MOVING MACHINE

A new dirt moving machine working on the endless cable principle is being employed in road grading in Iowa. It consists essentially of an endless cable running over a series of sheaves and carrying slip scrapers. The arrangement is known as the C. & S. Cable Pull. It was developed by P. M. Caldwell and W. H. Salyers of Malvern, Ia. The patented power plant is made up of two large spur-wheels each made from the same pattern. Into these is cast a receptacle for the purpose of inserting a lug which is cast on to a sheave. This sheave also has on the opposite side from this lug a receptacle so that several sheaves may be tied to this one large spur-wheel, and dispense with the use of key seats in shaft, spur wheel and sheave. On one of these spur-wheels three sheaves are used and on the other, two sheaves. The spur-wheels are driven by an 8¼-in. pinion, which is driven by a 28-in. spur-wheel on the same shaft, and this 28 spur-wheel driven in turn by a 7-in. pinion on the belt wheel shaft. The cable is so threaded onto these sheaves that it gives the minimum amount of friction. In front of the machine there is a tower from which is suspended a weight of 300 lb., that the idle cable runs over. This keeps the cable taut on the sheaves and reduces the slippage on the cable to the minimum. The plow steel cable (on one job it was 3,300 ft. in length) runs



C. & S. Cable Pull Dirt Mover.

from the power transmitting plant across the fill to be made and onto the hill where the cut is to be made. The 7 cu. ft. slips are then attached to the cable with a grab upon which a patent is pending. They are drawn by the cable to the top of the hill or to the place where they are to be loaded. Where met, detach the grab from the outgoing cable and one man attaches the grab to the return cable, while one man is filling scraper. The scrapers are easy to fill and of course run with the cable back to the fill, where a man is stationed to dump the slip. This outfit on a [illegible] job last summer in Mills County, Iowa, is stated to have moved [illegible] to 300 cu. yd. of dirt per day with a gang of [illegible] men. Seven of these were paid $[illegible] each per day, one was paid $6 and the engineer received $8. Two tons of coal costing $10.50 per ton delivered at the machine were used. No team of horses was used.

NEW ¾ YD. REVOLVING SHOVEL

A ¾ yd. revolving type steam shovel has been added to the line of the Marion Steam Shovel Co., Marion, O. The engine has 7 in. bore by 6-in. stroke and is controlled by control valve contained within the [illegible] and operated by a single lever. The boiler is of the [illegible] type, [illegible] in. in diameter by 8 ft. high. The construction includes such features as manganese steel propelling gears and pinions, hammered steel shafts of liberal proportions and basic open hearth steel castings properly annealed and heat treated. The shovel, while primarily designed for steam shovel work, is so constructed that it can be converted into a clam shell, orange peel or drag line excavator. Proper provision is made for the reception of the various parts required for these machines so that the standard shovel can be readily changed into any one of the above excavators. Due to its small size and compact construction this shovel can work in places hardly more than large enough for a house and its greater [illegible] range enables the operator to dig close up to the [illegible] itself as well as the front. [illegible] radius [illegible] the shovel. In [illegible] it is impossible to [illegible] close up to the shovel on the same grade, the increased "long reach" and "high dump" eliminate considerable maneuvering and prevent loss of time. The shovel can be mounted on crawling tractor trucks, wide face traction wheels, or railway wheels.

Marion 21. ¾-Yd. Revolving Shovel on Crawling Traction Trucks.

A NEW P. & H. EXCAVATOR CRANE

A new excavator crane [illegible] designed for operation [illegible] has been brought out by the Pawling & Harnischfeger Co., Milwaukee, Wis. This is a [illegible] capable of a variety of [illegible], excavating and [illegible] backfilling material [illegible]. It is a development from the P. & H. 206 excavator with [illegible] capacity [illegible] and [illegible]. It is [illegible]

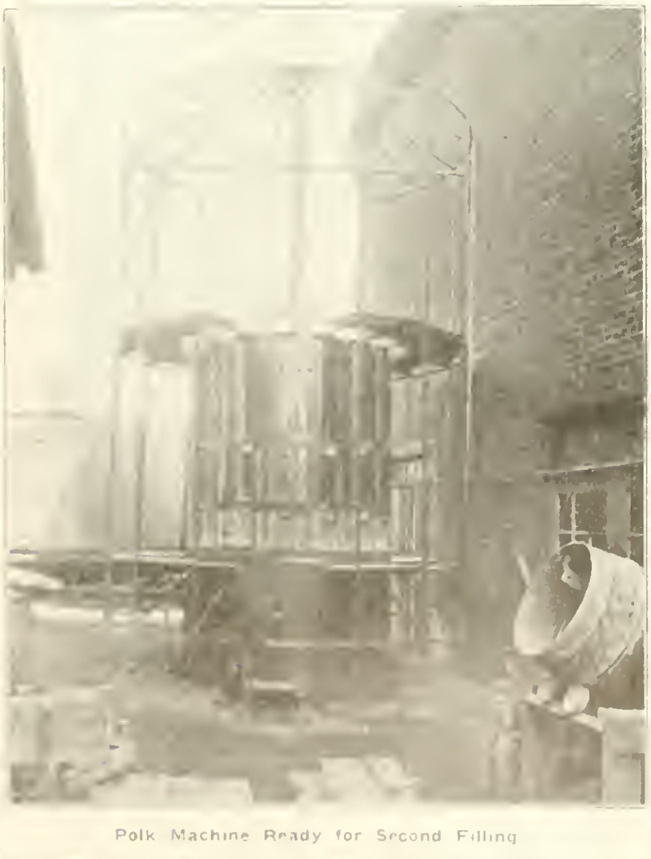
P & H [illegible]

[illegible] yd. bucket of 30 ft. [illegible] bucket [illegible]. The corduroy tractor is [illegible] to center approximately [illegible] in. wide, treads [illegible] self-cleaning, self-adjusting to ground levels, [illegible] manganese steel, bronze bushed, adjustable to take up wear. Crawlers operated [illegible] by large jaw clutches [illegible]. By pivoting on one [illegible] can be turned [illegible] in space [illegible]. It is equipped with [illegible] travel speed, one [illegible] high [illegible] one very low for operating in difficult soil conditions. The revolving frame is heavy semi-steel center casting, structural sub-frame, very rigid, rollers bronze bushed; roller track, 55½ in. diameter, center king pin provided with threaded capstan nut adjustable to take up wear, all parts bronze bushed; swing speed 3¼ R.P.M. The motor is a four cylinder Waukesha, heavy duty 5 in. x 6¼ in., magneto with impulse starter, master carburetor, Stewart's vacuum feed; storage tank sufficient for approximately 20 hours' operation. The dragline and hoisting speeds are 100 ft. per minute. The machine weighs 39,000 lbs.

MACHINE FOR BUILDING CONCRETE STACKS

A concrete chimney building machine has been developed by the Polk Genung Polk Co., Fort Branch, Ind. As in this company's concrete grain storage [illegible] silo machines the underlying principle of the chimney machine is the steel centermast which carries the entire construction equipment. By virtue of this mast, and the set of radiating steel tees, it is claimed an unusual accuracy in every line of the chimney is made possible, and the uniformity of the taper positively made sure. The wall forming shells are sheet steel, framed with small angles, in such a manner that they may overlap as the diameter of the stack decreases. In each section of outer forms a rib forming corrugation is stamped. For placing reinforcement these outer forms are readily removed, leaving complete access to the work. The machine carries its own working platforms, the supports of which are elaborated into a steel inclosing cage over which a canvas envelope is stretched for protection from unfavorable weather. There is no scaffolding either inside or outside the chimney at any time, the workmen using the construction ladder which hangs from the machine. The accompanying illustrations show a stack constructed by this method. One of these was built for the Indiana Lumber Co., Kokomo, Ind. It is 80 ft. high above ground and has an outer bottom diameter of 6 ft. 8 in., an inner bottom diameter of 5 ft. 4 in., outer top diameter of 4 ft. 8 in., inner top diameter of 4 ft., a wall thickness of 8 in. at the bottom and 4 in. at the top. This stack was built at the rate of 6 ft. per day.

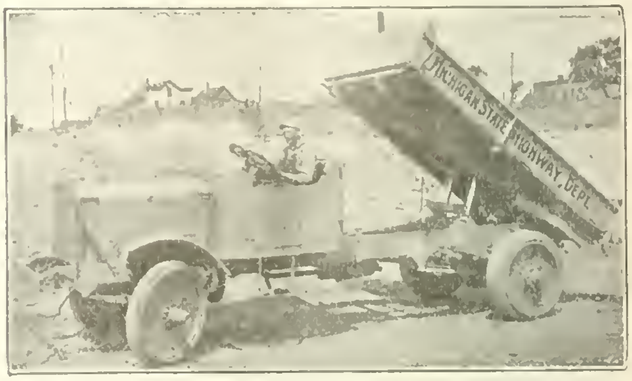
Reinforced Monolithic Concrete Stack Built by Polk System.



Polk Machine Ready for Second Filling

HYDRAULIC HOIST FOR TRUCK BODIES

A simple and powerful type of hydraulic hoist for truck dump bodies has been brought out by the Hydro Hoist Co., the general selling agents for which is The Heil Co., Milwaukee, Wis. Four sizes of the hoists are being made. The No. 4 is used on trucks rated to 3 tons capacity the No. 5 on those rated to 5½ tons; and No. 6 for extra heavy duty work. The No. 7 hoist is built for all four wheel drive motor trucks which have the propellor shaft on the side. It is rated for trucks up to 3 tons capacity. The hoist is extremely simple in its construction. All pipes, cables, pulleys, rollers, arms and the like are eliminated. This simplicity makes it easy to operate and care for as well as reducing the number of parts which may cause trouble. The hoist consists of one or two vertical cylinders, mounted on the chassis frame just in front of the rear axle and about in line with the front shackle of the rear spring. Its location is where the chassis can best support it. The cylinders and tank contain cylinder oil (medium heavy in summer—ice-machine oil in winter) which oil is forced from the upper part of the cylinders to the bottom of the cylinder by a gear pump. This pump is located in the manifold just in front of the cylinders. The power to drive the pump is taken from the transmission or unit power plant. By means of a lever located in the cab, a clutch or sliding gear is operated. This drives a shaft, which transmits the power. As the pump rotates oil is carried through the pump and forced out through a ball check valve into an oil way that leads to the bottom of the cylinders. There the force is applied directly to the piston head. The piston moves up until it shuts off the supply of oil going into the pump. This automatically stops the hoist. The pump can continue to rotate as it turns in its own bath of oil. A valve which permits the oil to by-pass the pump allows the body to come down. This valve is also operated from the seat. The body can come down only as the oil in the lower part of the cylinder is displaced. A number of improvements have been made on the hoist since it was originally put on the market. A beveled manifold is now used which gives a slightly reversed angle on the universal joint nearest the hoist when the body is in the down position. When the body is in the raised position, the angle of the universal is about 18 or 20 degrees. The two pistons are of solid steel and prevent any twisting of the body when it is dumping on a side grade or has an unevenly distributed load.



Hydro Hoist.

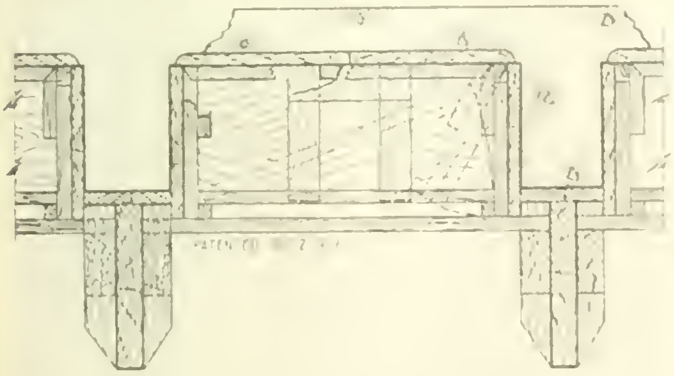
PLAN AND BLUE PRINT FILING CASE

A plan and blueprint filing c[illegible] tures was placed on the mark[illegible] Table & Mfg. Co., Adrian, Mic[illegible] "Pakfull" sections. Between ea[illegible] there is a frame on the unders[illegible] paper, which is flush w[illegible] of the frame, making the drawer run into a [illegible]. The drawer [illegible] protrudes up into this frame ¼ in. [illegible] paper from sliding over the top of the drawer [illegible]. There are also two dowels in the back of [illegible] this frame, which keeps the pa[illegible] of the drawer and into the rea[illegible]

front stops in a groove in the front of the frame, which makes the drawer dust proof. These are patented features of the case, and cannot be appreciated until after packing the drawers as full of blue prints and tracings, until not another one could be entered, then closing the drawer and after opening it up again, finding the tracings and blue prints just as they were when entered. These sections, it is claimed, will take more tracings or blueprints than any other horizontal section on the market, without the use of spring covers or holding down wires. The sections are absolutely dust proof and are decidedly neat and attractive in appearance.

WOOD FORM FOR RIBBED CONCRETE

An all wood concrete form [illegible] for ribbed concrete where the joists are on 24-in. to 36-in. centers, and which can be erected and removed without the use of nails or other fasteners, is illustrated. This centering is a rigid, self-supporting, non-leakable matrix that conforms inversely to the contour of the joists. It consists of light, preconstructed,

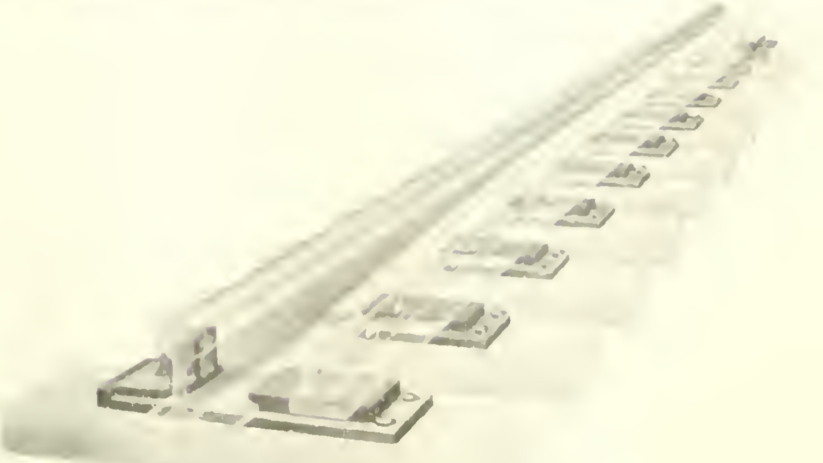


Branson System of Joistmold Centering

interfitting, interlocking elements, that can be made of stock lumber, by carpenters. It can be collapsed, removed and set up again in short time and can be reset and reused repeatedly. The centering is a composite of two groups of preconstructed units, whose manner of interfitting and interlocking permits removal of the second group ahead of the first, in order to reduce to a minimum the equipment required for any given job. These forms are known as the Branson System of Joistmold Centering. It is controlled by Bergendahl & Archer, 25 E. Jackson Blvd., Chicago, Ill.

A FLAT BASE SWITCH POINT

[illegible]

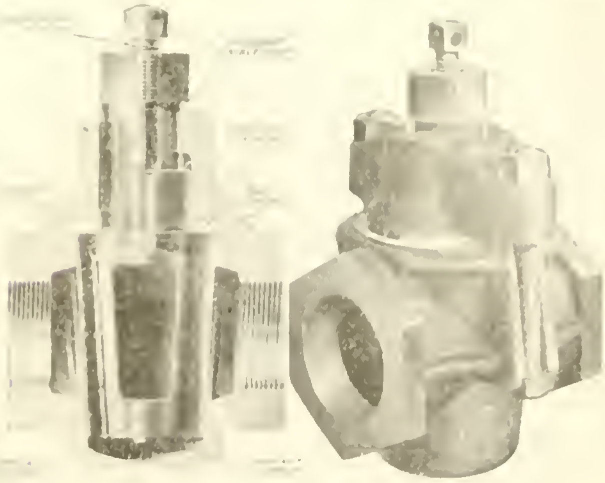


View of Switch Equipped With Flat Base Switch Point

base and bolt from all horizontal thrust. No bolts or tiller are required to hold the switch point in places. Elevated seat enables snow and ice to be easily removed, avoiding incomplete closing of the point. The switch is manufactured by the Positive Rail Anchor Co., Marion, Ind.

A NEW PLUG VALVE

A new plug valve in which ease of operation is claimed to be assured through constant, though minute, separation of the seating surfaces by a thin film of very viscous lubricant, has been placed in production by the Merrill Co., San Francisco. The economy of this valve is stated to be as much a matter of its perfect lubrication as its simple design and rugged construction. Body, plug and cover essentially constitute the valve complete. Lubrication is effected by applying pressure by means of a lubricant screw which forces the

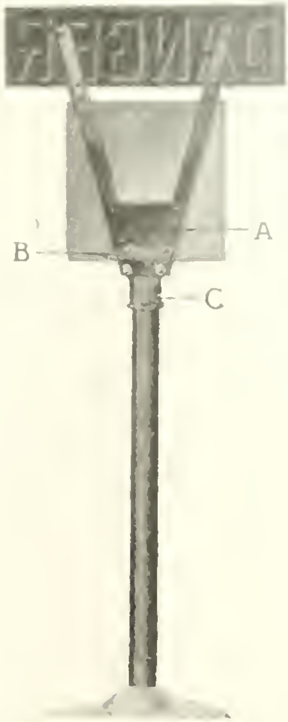


Merco Nordstrom Plug Valve.

lubricant through channels in the seating surface of the plug down into a chamber beneath the plug. The lubricant can then escape only by overcoming the packing pressure and forcing the plug up out of its seat. The escaping lubricant spreads itself evenly over the seating surfaces and floats the plug. Exposure of the lubricant channels to the pipe contents is absolutely prevented by a positive stop.

HIGHWAY SIGNAL OPERATES ON PRINCIPLE OF ANGULAR REFLECTION

Radical improvements in the focusing device of the Redflex lighting danger signals were made during the past year. The improved signal is shown in the accompanying illustration. The signals operate on the principle of angular reflection.

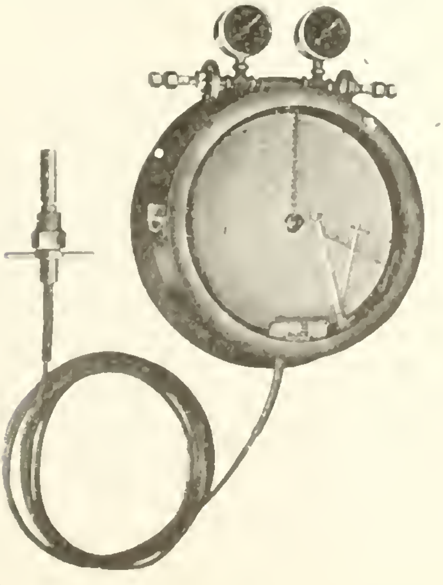


Back View of Signal Showing New Focusing Device.

When the lights of an approaching automobile fall upon the signal a commanding red light, appearing as a ball of fire, is returned to the driver.

A NEW TEMPERATURE RECORDING CONTROLLER

A new instrument which is claimed to insure absolute uniformity of control of temperature has been placed on the market by the Foxboro Co., Inc., Foxboro, Miss. A casual glance at the instrument discloses nothing different from other Foxboro recording instruments, but a closer inspection shows two arms on the chart. One of these holds the pen and records the temperature; the other carries a cross arm by means of which the pointer arm may be set to the temperature desired.

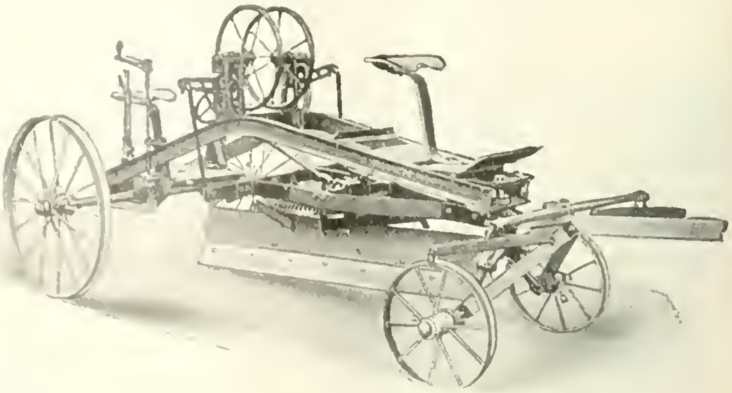


Automatic Temperature Controller Recorder.

and the mechanism will maintain this tempeature for a period as long as may be necessary. With this new automatic temperature controller-recorder but one bulb or thermal element is used for both control and record.

IMPROVED ROAD MACHINE

The Little Winner steel reversible road machine, as shown in the illustration, is a decided improvement on the old type machine of the same name. The new machine embodies all of the excellent features of its predecessors with a number of marked improvements in methods of operation. The improvements consist, in brief, of a simpler reverse, a more convenient standing platform for the operator, an improved fifth wheel arrangement and dust proof boxes and oil cups for the wheels. With the exception of a very few parts that take no strain, the Little Winner is constructed entirely of steel and malleable iron. The cutting blade is 6 ft. long. The machine weighs 1,600 lb. and can be used with two, three or four horses. It is made by The Good Roads Machinery Co., Inc., Philadelphia, Pa.



Little Winner Reversible Road Machine.

A MECHANICAL MUCKER

A compact mucking machine that will operate in small tunnels or drifts, where the heading is only 5 ft. wide by 7 ft. high, is illustrated. It is a compressed air operated machine, comprising three main elements, a truck with wheels suiting the gauge of the track; a platform or turn-table providing lateral movement to the shovel and a body member containing the operating cylinders, and shovel guide members in which the shovel and its arm function. The body-piece consists of four cast iron cylinders and their pistons; three operating valves, a cross-head which travels in horizontal guides and carries the rope sheaves to which are fulcrumed the dipper arms and the dipper. The machine is not of the continuous operation or cycle type, but each motion has a separate control that is reversible. The digging and loading movements are performed by the action of compressed air upon direct thrust pistons and require no gears, chains, clutches, belts, conveyors nor engines. The crew, required for shoveling operations, depends largely upon the tramming conditions. But one operator is necessary to load the cars, the number of additional men required being determined largely by the rate at which empty cars can be delivered to the machine. The machine is known as the Shuveloder. It is manufactured by the Lake Superior Loader Co., Duluth, Minn.

The Shuveloder in Operation.

CONCRETING WITH MAST HOIST BUCKET PLANT

Two interesting examples of concrete construction on which the new Insley mast hoist bucket plant was used are shown in the accompanying illustrations. Figure 1 shows the work at the new Lion House at the Franklin Park Zoo, Franklin

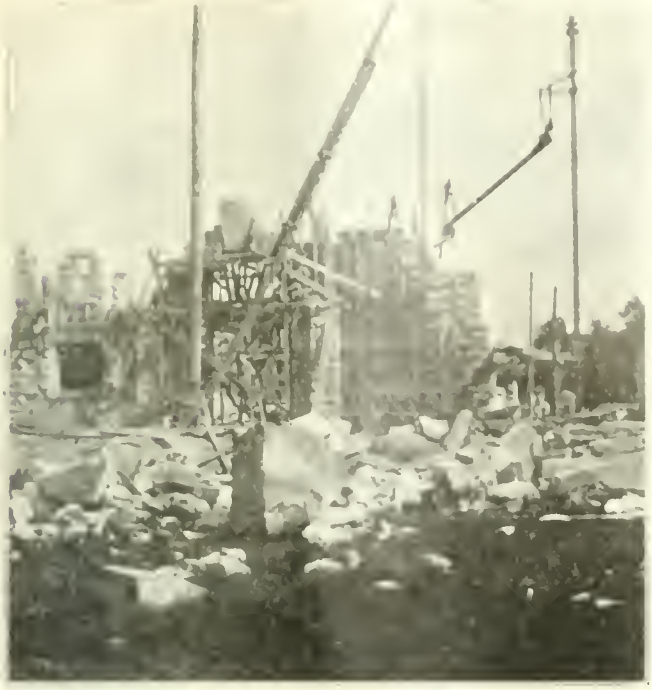


Fig. 1—Concrete Chuting System at New Lion House, Franklin Park Zoo, Boston.

Park, Boston, Mass., for which A. Piotti of Boston was the contractor. This is a cut stone job backed up with reinforced concrete, this with the concrete floors requiring the total yardage of about 2,[illegible]. The specifications required

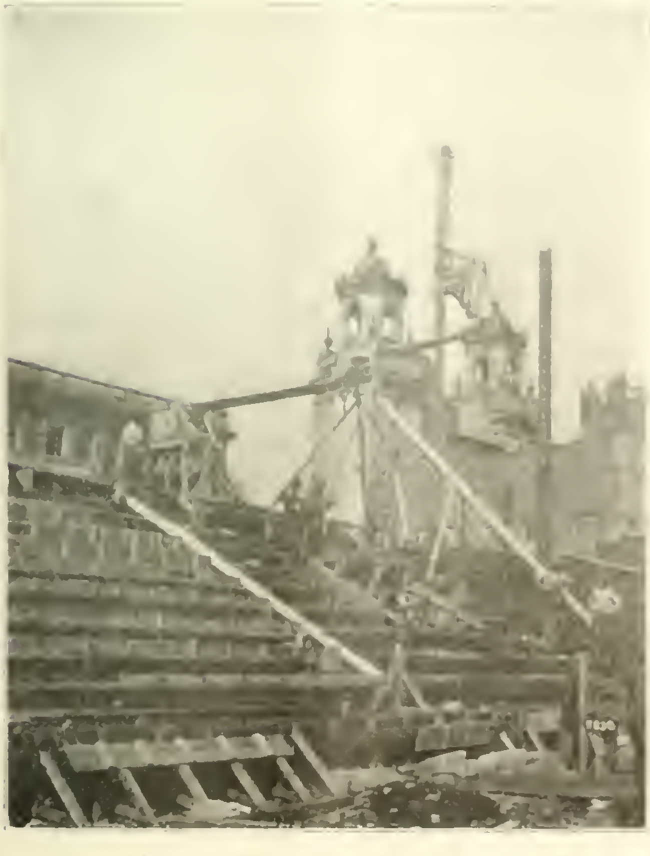


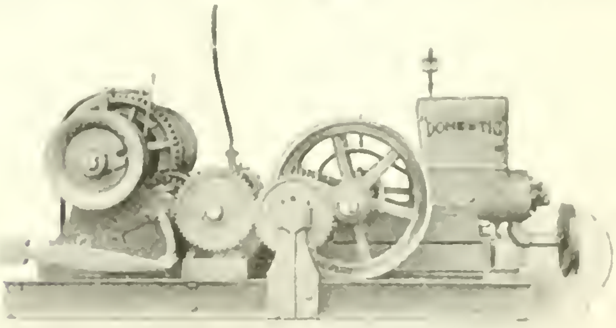
Fig. 2—Concreting Operation at Boston Arena With Mast Hoist Bucket Plant.

that the cut stone should be set in place before the concrete was poured in the back of it, making a very hard concrete job. The contractor, however, was able from the setup to [illegible] the concrete [illegible] forms without wheeling a pound of concrete. The mast on this job was [illegible] ft. high piece of built up section [illegible] hoisting boom. The plant consisted of a 7 H.P. gasoline engine operating a [illegible] Smith mixer. Mr. Piotti [illegible] cu. yd. of concrete per hour [illegible] the [illegible] that the [illegible] plant was operating.

Figure 2 shows [illegible] hoist bucket plant operating on the Boston Arena [illegible] for which Wm. M. Bailey Company [illegible] were the contractors. There were about [illegible] of concrete in the [illegible] and the [illegible] of the building being [illegible]. The [illegible] ft. [illegible]. The mast shown in the photograph [illegible] ft. [illegible]. The [illegible] equipped [illegible] with a [illegible] Smith mixer [illegible] of the tower. At [illegible] the tower.

A NEW BUILDING HOIST

An interesting hoist that [illegible] requirements of building contractors in providing [illegible] operation for platform elevator and concrete hoisting and general line hauling has been brought out by the Domestic Engine & Pump Co., Shippensburg, Pa. The hoist is made in 6 Hp. and 8 Hp. units. It has a grooved sheave 11 [illegible] in. at smallest diameter located outside journal box on one side, a cylinder hoist drum, 17 in. long between flanges, located between journals, and a tapered winch keyed to drum shaft located outside journal box on opposite side from sheave. The sheave and drum are each equipped with a quick release device which enables user to operate a double cage elevator or do general hoisting without having to remove either cable. By releasing both drum and sheave loose end line hauling can be done with winch. The hoist is designed so operator can stand facing the load and grasp the control lever with his right hand. This control lever of hoist is supplemented by the engine speed lever and hoist foot brake both so conveniently located that operator can use them without changing his position. Control of hoisting in either direction is effected with a single lever. This lever controls operation of hoisting with drum, elevator sheave or winch. Starting, stopping or reversing can be done instantly. The clutch is a specially designed friction clutch which allows the operator to pick up load gradually, avoiding sudden jerks. The friction surfaces are extra large in area, making possible operation of hoist with maximum load without slippage. The engine is a Domestic heavy duty, single cylinder, four cycle water cooled type.



Reversible Builders' Hoist, With Gear Guard Removed

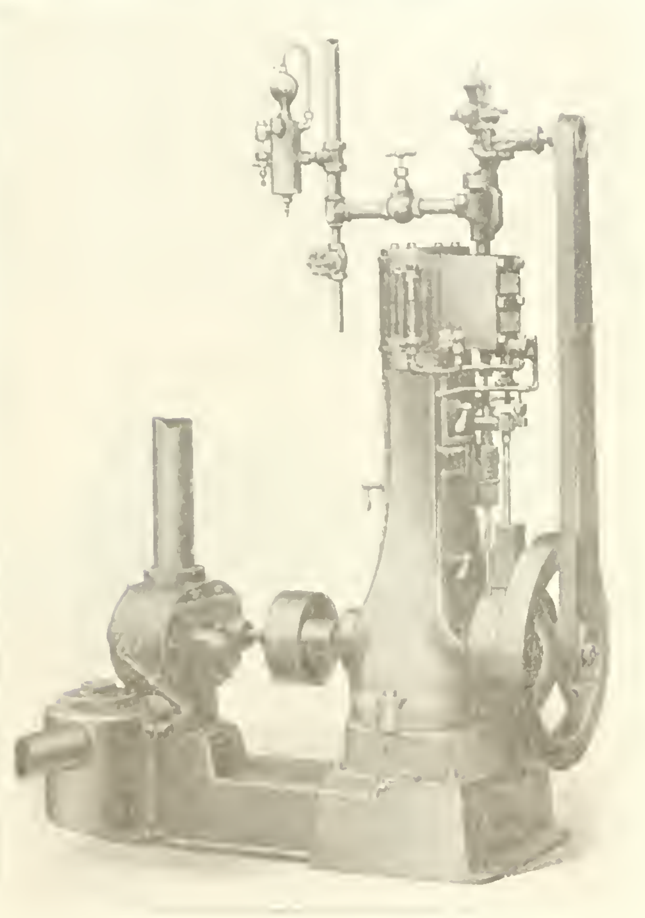
MOTOR DRIVEN PORTABLE AIR COMPRESSOR.

A portable air compressor driven by electric motor has been brought out recently by the Sullivan Machinery Co., Chicago. The equipment consists of a standard class WG-6 Sullivan single stage belt driven compressor with inlet valve unloader as supplied on ordinary stationary units of this type. The compressor and motor run at constant speed, and when the pressure in the receiver exceeds the pre-determined limit, the pilot valve on the side of the air cylinder acts under the impulse of air from the receiver, to raise the inlet valves from their seats, thus allowing the piston to reciprocate without load until the air pressure in the receiver again falls. When the pressure on the pilot valve is released, the plungers underneath the air inlet valves drop, thus allowing the valves to seat and compression to be resumed.

The inlet and discharge valves are of the improved Sullivan wafer pattern, consisting of thin rings of spring steel [illegible] is separately [illegible] against steel [illegible]. This arrangement affords a very short valve travel and a relatively wide port opening, furnishing excellent volumetric efficiency. The air cylinder is cooled by a [illegible] top and filled from a bucket type [illegible] with water piping and circulating pump. The [illegible] totally enclosed type and the main working parts are oiled by the splash system. Either direct current or alternating current motors may be supplied as desired and the compressors are furnished in several sizes from 100 up to [illegible] cu. ft. of air per minute, to suit customer's requirements. The outfit, together with the air receiver and electrical apparatus, is mounted on a structural steel frame or truck, the whole being covered by a metal top or canopy with [illegible] curtains to protect it from weather.

STEAM JACKETED ASPHALT PUMPING SYSTEM

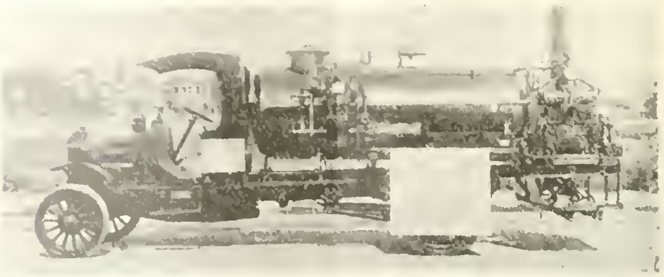
A steam jacketed asphalt pumping system made by Warren Bros. Co., Boston, Mass., is illustrated. The fittings are designed to permit direct passage of the steam from the pipe jacket through the jacketed fittings by means of ports in the fittings. The asphalt pump and strainer are also steam jacketed. The pump has a capacity of 100 gal. per minute at 150 r.p.m. and 160 gal. per minute at 300 r.p.m. The asphalt discharge gate provides for carrying the steam jacket directly up to the outlet of the asphalt pipe. The pump has a 3 in. inlet and a 3 in. outlet and provides for a 4 in. steam jacket on asphalt line opening directly into pump jacket, or for the steam being piped into pump jacket through a pipe from the heating lines in unjacketed asphalt piping. This 4 in. jacket with a 3 in. asphalt line allows a steam space of ½ in. plus, and provides a steam area surrounding the asphalt line equivalent to that of a 2 in. pipe.



Asphalt Pumping Outfit.

ROAD SPRAYING OUTFIT

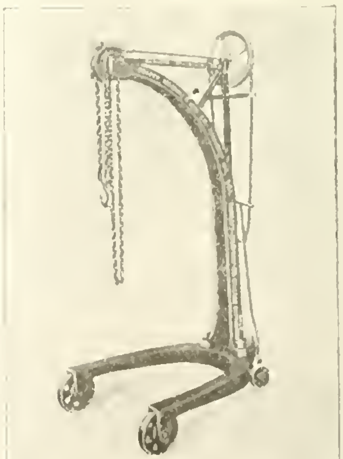
The latest type of Cressy road sprayer is shown in the accompanying illustration. This machine can be mounted on any make of truck. It can be attached to the truck in two hours, and requires no power from the truck to operate it. The tanks hold from 500 to 1000 gal. and are tested to stand 100 lb. pressure. The outfit is fitted with steam coils to heat the material and keep it hot for days, if necessary. An air compressor is mounted on the side which furnishes air to agitate the material, and is so arranged to load the tank by vacuum when so desired. A small boiler mounted on the rear furnishes steam for heating the material, to run the air compressor and to thoroughly heat and clean the spray pipes. The outfit is mounted on channell iron and is complete in one unit, being fastened to the chassis by U-clamps around the frame. This sprayer is made by the Cressy Road Sprayer Mfg. Co., Everett, Mass.



Cressy Patented Sprayer Mounted on Motor Truck.

PORTABLE FLOOR CRANE

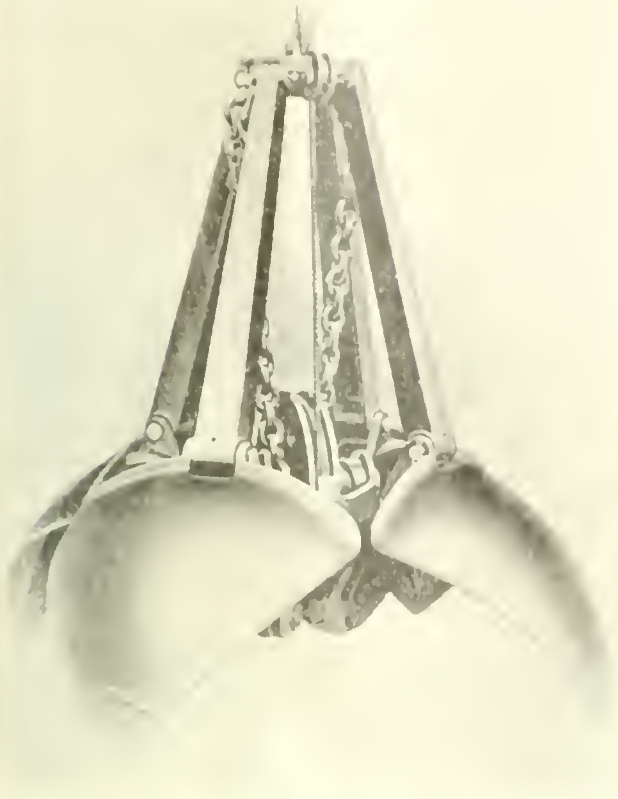
A portable floor crane, said to be the only machine of its kind on the market equipped with the worm and gear type of hoist, has been brought out by the Barrett-Cravens Co., Chicago. With this type of hoist the load can be raised to exactly the desired height, even to within a fraction of an inch. The load is automatically locked at all points of its travel, thereby assuring safety even when the hoist is used by a careless operator. All-steel construction is employed. The crane base and column are steel castings, and the hoisting device rests on the column arm. The wheels on which the crane is mounted are provided with chilled treads to insure good wearing qualities, while their webs are left soft to give strength. Hyatt roller bearings are used in all wheels so that heavy loads may be pulled easily. The hoisting mechanism consists of a worm gear constructed of bronze, a screw cut from solid steel shafting, a steel sprocket designed with a wide factor of safety over the rated capacity, and an electrically welded chain intended to give the greatest strength with the least possible weight. The screw and worm are enclosed in an oil-tight housing to permit proper lubrication. These cranes are known as the Hammond "Never-Slip" Portable Cranes. They are made in six sizes. The smallest, or No. 1 size, has a lifting capacity of 2000 lb.; a total height of 6 ft.; a lift of 4 ft. 10 in.; an outside width of bed of 3 ft. 6 in.; and an inside width of bed of 2 ft. The length of the bed is 3 ft., and the height 8 in. The weight is 575 lb. The largest, or No. 6 size, has a lifting capacity of 7000 lb.; a total height of 10 ft. 8 in.; a lift of 8 ft. 6 in.; an overhang of 3 ft. 8 in.; an outside width of bed of 4 ft. 3 in.; and an inside width of bed of 3 ft. 6 in. The length of the bed is 4 ft. 10 in. and the height 12 in. The total weight is 1400 lb.



Hammond Portable Floor Crane.

NEW ORANGE PEEL GRAB BUCKET

A new design of orange peel grab bucket [illegible] corporated several novel features [illegible] market by the Mead Morrison [illegible] ton, Mass. In this bucket the [illegible] casting of steel, this giving [illegible]

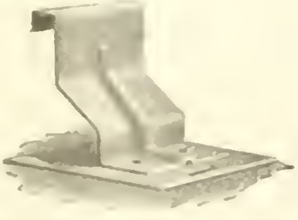


New Mead-Morrison Grab Bucket

[illegible] handle ever [illegible] after long use. The [illegible] are also of cast steel, "I" shaped and tapering, not only to give maximum strength but also to give a wide bearing surface where the links fasten to the segments. The chain is wound upon a cast steel chain winding drum and as the chain does not wind upon itself the closing power remains at a maximum throughout the operation. The top head of the bucket has a smooth surface so that there is no place for the closing rope to become caught. The segments are fitted with manganese steel points which can be easily removed and replaced after they become worn. This grab bucket has a capacity of [illegible] cu. ft.

HEAVY DUTY ROAD FORM

A heavy duty steel form for road construction was brought out this year by the Heltzel Steel Form & Iron Co., Warren, O. The bottom flange of the rail is 4 in., 9 gage metal being used. An offset pedestal shown in the cut is used. The rail rests on the base plate of the pedestal, which prevents it from tearing or buckling under the vibrator and strain of the finishing machine and also prevents sinking when the subgrade is soft. As now manufactured the rail is stated to withstand a live load of [illegible] tons. The upright of the pedestal is made of heavy pressed steel, 5½ in. wide, reinforced with a pressed rib in the center and further strengthened with an extra depending flange to support the road rail. It [illegible]



Offset Pedestal.

IMPROVED FEATURES OF REX PAVER

[illegible] 1921 model Rex 21-E Paver [illegible] The discharging operation has been speeded up by the use of an automatically controlled [illegible] mechanism which [illegible] The distributing bucket is designed to [illegible] spreading action as the batch is being dropped. This is accomplished by an inverted V shaped spreader [illegible] at the bottom of the bucket and the spreading area is increased to such an extent that less labor is required for [illegible]. To operate a paver at top speed and maintain that [illegible] is no easy task for an operator. The Rex 21-E Paver has been designed and equipped with easy to operate mechanisms and automatic knockouts are used for the loading skip, boom and bucket and discharge chute. The discharge chute is operated and controlled through an enclosed transmission in which cut gears running in oil are used. The shaft is mounted on Hyatt roller bearings and the entire arrangement enclosed in an oil tight, dust proof case. The automatic knockouts for releasing and holding the discharge chute in either charging or discharging position are also enclosed in this case. A similarly enclosed transmission running in oil, as used on auto trucks, controls the forward or reverse traction of the machine.

The operator's platform has been raised and places the operator where he can see both the charging and discharging end of the machine at the same time. The control levers are all within easy reach from one position and operate with a minimum of effort.

RAPID DISCHARGE CONCRETE MIXER

A concrete mixer, having special bucket and paddle construction is illustrated. It is claimed for this mixer that the peculiarly shaped buckets and blades not only make for an exceptionally fast mix, but the shape of the blades is such that they throw all of the batch into the buckets when discharging, speeding up the discharge and leaving the drum very clean. The mixer is equipped with roller bearings throughout and the mixing drum is balanced to eliminate vibration. The sheet metal parts are high carbon steel and all semi-steel castings are of genuine charcoal iron. Fairbanks Morse engines are used on the gasoline powered machine and Fairbanks Morse motors on the electrical driven machines. The steam equipment consists of O. & E. vertical engines and A. S. M. V. boilers. The mixer is made by the Judy Manufacturing Co., Centerville, Ia.

Giant Concrete Mixer

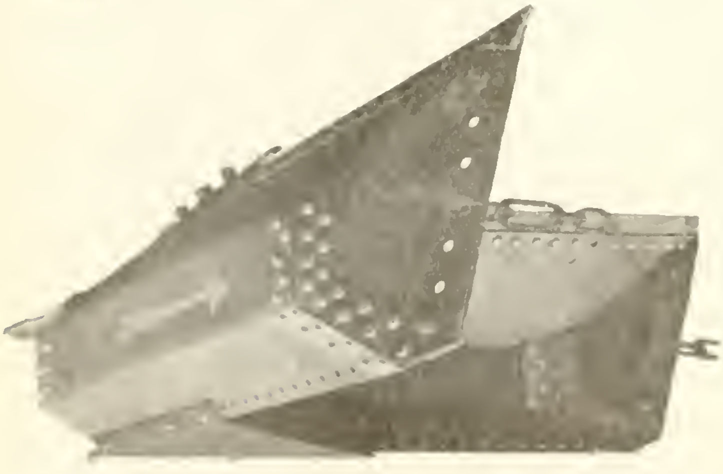
NEW INDUSTRIAL GASOLINE LOCOMOTIVE

A new industrial friction drive gasoline locomotive brought out by the Hatfield Penfield Steel Co., Cleveland, O., is illustrated below. These standard type locomotives are being built in gages from 18 in. to 56½ in. and from 4 to 7 tons weight. The engine is a heavy duty Hercules 4-cylinder vertical type Model C. F. 2. The cylinders are 3¾ in. bore by 5¼ in. stroke. Piston displacement, 226.42 cu. in. developing 27 H.P. at 1,000 r.p.m. The special features of the engine are: Five main bearings on crank shaft, eliminating crank arm deflections and the excessive vibration due to these deflections, also reducing the internal losses and increasing the mechanical efficiency. The five bearings also maintain extremely low bearing pressure, which insures long life of the bearings. Other features of this locomotive include: Efficient cooling system, including tubular type radiator, extra heavy, enclosed fan and water pump for water circulation. Telescopic design coupling, enclosed in bell housing. The housing is machined and fits accurately on the inside of side frames resting in pockets cast on the inside of side frames and bolted as well. Self aligning axle bearings, providing against cramping on uneven rail. Use of hardened steel sleeves on axle and jackshaft bearings. All drive chain encased in housing with removable cover, chain constantly taking a bath of oil and thoroughly lubricated. Positive sanders to all wheels. Direct and proper vision for operator at all times, from natural sitting, operating position.

4 Ton H.P. American Industrial Gasoline Locomotive

A POWER DRAG SCRAPER

A power drag scraper of the bottomless type that can be adapted to a number of uses is illustrated. It is operated by standard construction equipment, 2-drum hoist, cables and sheaves. The top and bottom of this scraper are so alike that when one side is worn out it can be reversed, thus giving double length of service, or teeth can be attached to one side so that all that is necessary is to turn the scraper if the material varies from hard digging to loose material. It also can be equipped with carrier to return by slack line if desired. It is claimed that this scraper is especially adapted to getting material from under water as a few seconds' stop will allow the water to drain off along the side so that the material will be quite free from water and will round up in loading wagons or will stay in embankments. This scraper is known as the Arrow Power Drag Scraper. It is made by L. P. Green, Lumber Exchange Bldg., Chicago.



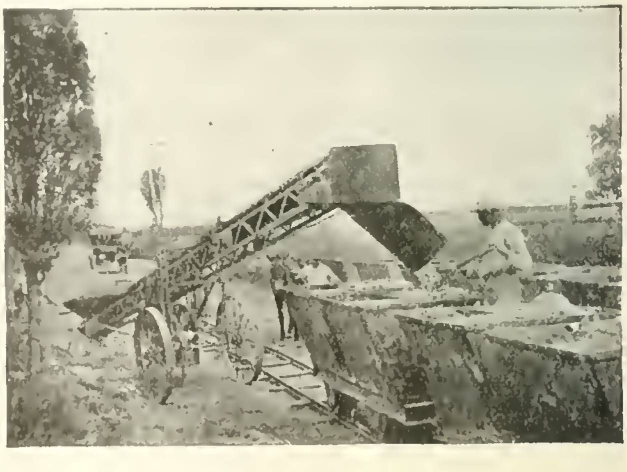
Arrow Power Drag Scraper.

NEW DUMP BODY MECHANISM FOR FORD TRUCKS

An improved Ford dump mechanism, known as the Standard Ford speed dump, has been perfected by the Standard Steel Works, of Kansas City, Mo. It is designed for 1-ton Ford trucks and is adapted particularly for quick hauls. This device has proved highly successful in practical tests. The dump is wrought iron throughout and is operated from the driver's seat by a hand lever. No mechanism is connected with the truck power. An automatic locking device prevents the body from slipping back and the contents can be dumped at will by operating the hand lever. The Standard Ford speed dump, including steel body, varies in capacity from 27 cu. ft. to 40½ cu. ft. and has a total weight of 450 to 550 lb. The dumping device alone weighs 165 lb. The dump can be installed on any Ford truck chassis in 10 minutes.

SELF FEEDING PROPELLING AND CROWDING WAGON LOADER

The accompanying illustration shows a recent development in labor saving devices. The self feeding attachment of this loader consists of 12 propeller blades and are fixed rigidly around an extended tail shaft. When a bucket elevator starts this long tail turns and the propeller blades, spaced evenly along its full length begin revolving and pushing shovelfuls of material toward the bucket. Incidentally they clean out a path for the wheels of the loader permitting the machine to move in for more material as fast as it is dug away, and thus relieving several laborers from the task of trimming to the wagon loader elevator buckets. Each propeller blade acts as a separate unit, operating with a slow, continuous rotary motion. These loaders are known as the Haiss "Path Digging" wagon loader. They are operated by electric motor and gasoline engines. Some types are built as high as 16 ft. under the loading chute and with four cylinder 30 H.P. engines. They are made by the George Haiss Mfg. Co., New York.



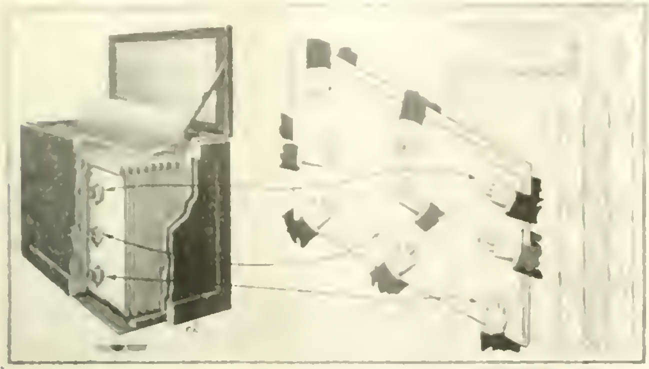
Haiss Loader

TWO WHEEL TRACTOR SCRAPER.

A 2-wheel tractor scraper was brought out early this year by Smith & Sons Mfg. Co., Kansas City, Mo. This machine, known as the Roytract, is built around the Rayol one man riding wheel scraper of the above mentioned company. Many trains of five Roytracs are operating, as well as numerous trains of threes. The big features of these scrapers are that only two men are required to operate a train consisting of tractor and any number of wheelers (one man on the tractor and one man on the scrapers) and the increased production gained by speeding up with tractor machinery, and the tracking abilities of the scrapers. This latter is a very important one as many times it is necessary for the train to take sharp curves or corners, and the scrapers have been so designed that they will track behind one another.

PLAN FILING EQUIPMENT

An improved method of filing tracings, blueprints and drawings is illustrated. Under this system tracings, etc., are placed in an indexed holder and held perfectly flat and smooth in a vertical position by spring compression. The method is known as the Economy Plan file. Some of the advantages claimed for it are: Saving of 33 1-3 per cent to 50 per cent floor space. Better preservation of drawings; [illegible] use of folder; drawings easily and quickly located; drawings kept perfectly flat and smooth. No jamming or crushing; twenty-four-inch space is all that is required to operate the planfile; index always in sight when file is being operated; spring compression holds drawings vertically and prevents wear on tracings, as they are handled in large folders same as letters. Locking of one planfile protects from 4,500 to 5,000 drawings. The planfile is made by the Economy Drawing Table & Mfg. Co., Adrian, Mich.



Sectional View of Planfile; Principle of Compression. Cross Section of Planfile Pocket and Folders on Line AA.

4-WHEEL HEAVY DUTY, REVERSIBLE TYPE TRAILER

A high speed, heavy duty, reversible type trailer equipped with a patent equalizer which prevents the wheels from spreading, and also keeps them in alignment with the truck when the springs compress under heavy loads, is illustrated. This trailer is equipped with Continental axles and Timken bearings. The springs are made of alloyed steel. It has a drop forged draw bar with spring cushion, one spring for pushing and one for pulling. The springs are suspended so as to absorb road shock and to insure freedom from rocking. The trailer is made in four sizes, 1½ ton, 2½ ton, 4 ton and 6 ton. It is manufactured by the Highway Trailer Co., Edgerton, Wis.

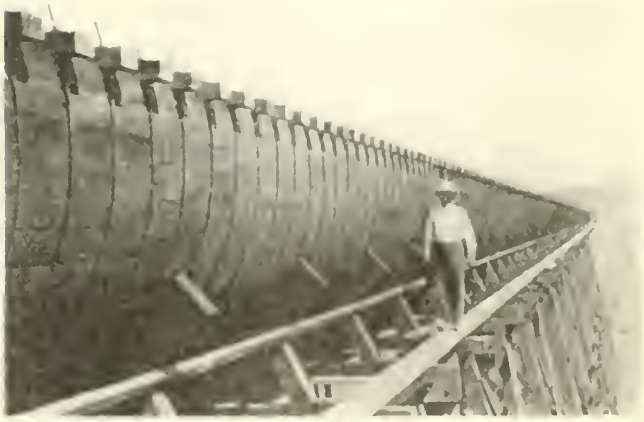
Highway Trailer

REAR DUMP BODY FOR TRAILERS

Some new features have been incorporated into the rear dump body which is now supplied as ordered on the heavy duty 4-wheel trailmobiles by the Trailmobile Co., Cincinnati, O. The tailgate may swing open either from the top or the bottom. If cinders, coal or some loose material is being hauled it will swing from the top as a pivot opening at the bottom and allowing the [illegible] in the usual way. The tailgate may also swing at the bottom as pivot and in that case it will act as an extension of the body floor so that bricks and fragile material, which can not be allowed to fall, will slide out directly onto the ground and there will be no breakage. Bags of cement can be unloaded in this way without breaking the bags or spilling the cement. This trailmobile dump body is fitted onto a hinged frame similar to that used in the trailmobile lumber dump bodies. This makes it much easier to dump. The overhang behind the point where the frame is hinged is about one-third of the length of the body and will carry about one-third of the normal load. In dumping the weight which overhangs assists the dumping movement by balancing another third of the weight which is forward of the hinge point. The result is that in dumping with the hand crank one-third of the load has to be moved. The rest of the weight is taken care of automatically. The dumping mechanism works at two speeds. The slowest speed can be used for very heavy loads or for starting a normal load. After it has been raised a few inches with the low speed, a dog on the side of the frame of the dumping mechanism can be set to hold the load while the gear is transferred to the higher speed shaft. Then the body can be quickly raised the rest of the distance. This makes a body that is easily handled by one man and can be dumped anywhere in two minutes. These dumping bodies are furnished in 1 yd., [illegible] yd., [illegible] yd. and 4 yd. capacities.

A CREOSOTED WOOD FLUME

A creosoted wood stave flume of semicircular design, designed for irrigation, mining and power projects was developed this year by the Continental Pipe Manufacturing Co., Seattle, Wash. This flume, an installation of which is shown in the accompanying illustration, has no joints and is carried on cradles, which is claimed to positively avert deflection, sagging or deformation of any sort. The flume is manufactured and shipped—in knocked-down form—to rail destination and installed in place.



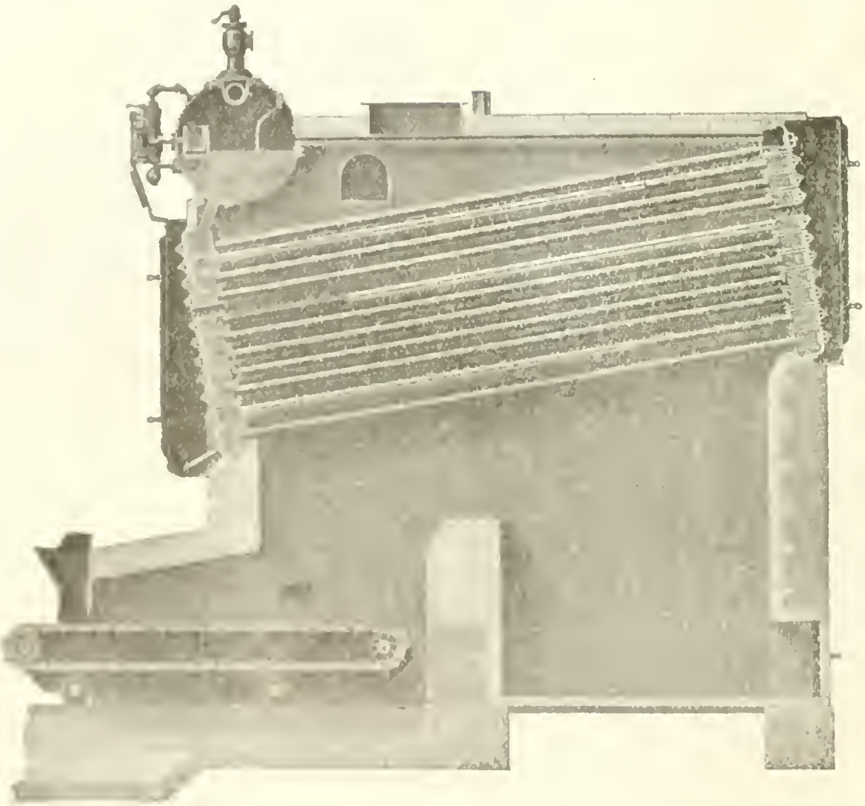
Installation of Continental Creo-Wood Flume.

A LIGHT WEIGHT SHARPENER FOR HAMMER DRILL STEEL.

A new model of the Sullivan drill sharpening machine, embodying the same principles as the older sharpener, but of smaller and lighter construction, has been brought out by the Sullivan Machinery Co., Chicago. This machine is known as the Sullivan Class "B" Sharpener, and is designed for handling solid or hollow steel of any section up to 1¼ in. in diameter, and to make bits up to a maximum gage of 2½ in. The Class "B" Sharpener weighs 1,500 lb., as compared with 4,000 lb. for the larger machine, occupies a floor area of 4 by 2¼ ft., and stands 5 ft. high. The essential features of the sharpener consist of a horizontal hammer cylinder and piston, operating a dolly for upsetting, and a vertical cylinder and piston operating dies for swaging the drill bits or shanks. For upsetting, the steel is clamped in steel dies mounted in the lower, or stationary, and upper, or movable jaws of a yoke or vise operated by a horizontal air cylinder situated in the base of the machine. The vise, or clamping cylinder and piston, are of the differential type, the closing or clamping end being 10 in. in diameter, and the releasing end 4 in. in [illegible] The action of the vise is controlled by a [illegible] placed in a valve chest on the side of the frame, and operated by a hand lever from the front of the machine. A safety device is provided which makes it impossible for the sharpening mechanism to start until the steel is securely gripped by the vise. The two hammer cylinders are mounted [illegible] equipped with floating hammer pistons and a valve mechanism which imparts a blow of great strength and lightness to the dies and dollies. Air is admitted to the horizontal hammers by the same valve mechanism which controls the vise. In order to secure the advantages of the floating hammer piston in the vertical member of the sharpener, a novel construction has been employed. When air is admitted to the vertical hammer cylinder, the pressure acts on top of an annular piston fitted in the lower cylinder head, which forces the upper, vertical swaging die down against the steel and holds it in this position in the same manner as the hand blacksmith, or his assistant, holds the flatter or swage in hand forging work. The vertical hammer then strikes against the die, drawing out the corners of the steel to proper gage and thickness with a high degree of precision, and the same effectiveness as is the case with the older, model "A" Sharpener.

HEINE CROSS DRUM BOILER

A cross drum boiler for land service has been brought out by the Heine Safety Boiler Co., St. Louis, Mo. It consists of two box headers carrying a nest of inclined tubes and of a drum placed above and across, slightly to the rear of the front or lower header. The drum is connected to the top of each header by a row of tubes—short, nearly vertical, to the front header—and long nearly horizontal, to the rear header. The main nest of tubes, with the headers, form a virtually closed complete circulation system of remarkably low resistence owing to the capacious headers. The steam rises in the rear header, where its primary separation from the water is promoted by a device at the upper part. It then flows along the almost horizontal tubes, parting with most of the entrained water by gravity, to the final separator in the steam drum, where it is dried by centrifugal action set up by a deflector. The water carried into the drum is returned, together with the new feed water, to the circulation system, through the short tubes leading into the top of the front header. Steam is drawn from the ample storage space through a dry pipe extending nearly the whole length of the drum and provided with small holes on the upper side.



Longitudinal Section of Heine Cross-Drum Boiler With Chain Grate Stoker.

HIGH POWERED TRACTOR SCARIFIER

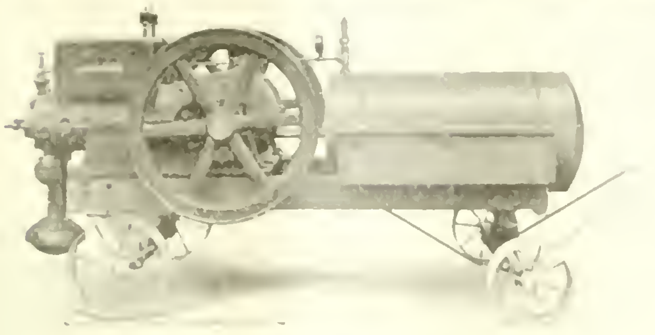
Road building in the mountain country, and in the arid and semi-arid regions, where the rainfall is light, is very difficult because the soil is so dry and compact it is a hard and slow task to plow or break it up, even with the tractor grader. In many sections, fast surface boulders are frequently encountered which, in addition to delaying the work, often do serious injury to both grader and tractor. To meet this condition a new scarifier has been brought out by the Western Wheeled Scraper Co., Aurora, Ill. The scarifier block is a solid steel casting made in one piece, 15 in. wide, 12 in. deep, and 3 ft. 4 in. long. The block sets at an angle of 45 degrees to line of travel. It carries 5 teeth for ordinary work, and two end teeth for bank work outside of tread of machine. The teeth for ordinary work, occupying the angle stated, readily cast aside big chunks of earth and stone too large to pass between them. The 5 teeth are each 2 in. thick, 6 in. wide and 18 in. long, interchangeable and easily and quickly removed. The two end teeth are the same size except as to length. The draft is absolutely direct. The tractor pulling directly from the scarifier draft bars. The machine weighs about 9,000 lb. and has a wheel base of 16 ft.

A ROAD GRADER DESIGNED FOR OPERATION WITH HIGH POWER TRACTORS

A road machine designed to meet the requirements of high power tractor operation was brought out this year by the Western Wheeled Scraper Co., Aurora, Ill. The grader weighs 9,000 lb. and has a 12-ft. blade. It has an absolutely direct draft—the pull is independent of the pole, which is only used for a guide, the engine being hitched to the blade draft beams direct. A one-circle fifth wheel not only eliminates friction, so that the offset hitch operates with surprising ease, but it also takes all twisting strains from the main frame when working in old ditches and over exceedingly rough ground. Two large compression springs on top of main frame transmit automatically, through a bell crank, their entire lifting force to the blade and its supporting mechanism so that the blade can be lifted with ease. The rear axle is long to afford the machine a broad bearing base. The rear wheels are pivoted to rear axle in the same manner as the front wheels on an automobile, and they are adjusted in the same way. This form of pivot operates with remarkable ease and quickness. The blade supporting mechanism and method of reversing the blade are unique. The blade supporting members are simple, strong and efficient. The [illegible] fittings are [illegible] so that the blade can be reversed or its angle changed easily.

NEW COMPRESSOR OUTFIT

A compact portable compressor outfit designed particularly to meet the requirements of the [illegible] kinds of construction work was added to the line of [illegible] compressors manufactured by Chris. D. Schramm & Son, Inc., West Chester, Pa. This new outfit embodies all the features of the smaller machines and is built along the same general lines. A number of these compressors [illegible] rock drilling [illegible] and [illegible] all [illegible] work, caulking [illegible] any class of work where [illegible] the channels and [illegible] compressor [illegible] the outfits [illegible] work [illegible]



Schramm No. [illegible] Compressor

DITCHER FOR CLEANING LATERAL IRRIGATION CANALS

A [illegible] lateral irrigation [illegible] placed on the market by the Western Wheeled Scraper Co., Aurora, Ill. This [illegible] the Western ditcher [illegible] the [illegible] and both edges [illegible] fitted with [illegible] removed for sharpening. The top of the [illegible] to conform to the [illegible] depth of the ditch [illegible] maintaining a [illegible] as the work progresses. The landslides [illegible] with steel [illegible] at both front and rear ends, and all [illegible] by them. They are [illegible] powerful and [illegible]. The ditcher [illegible] reversed simply by turning [illegible] lever. The machine will excavate or clean out a ditch 2½ ft. deep and [illegible] ft. wide at the top.

Some 1920 Books for Engineers and Contractors

Bridges and Buildings:

Design of Highway Bridges of Steel, Timber and Concrete. By Milo S. Ketchum, Professor-in-Charge of Civil Engineering, University of Pennsylvania. Second edition, entirely rewritten. McGraw-Hill Book Co., Inc., New York. 556 pages, 6x9, flexible. $6.

In this new, completely revised edition, the scope of the work has been extended so that the book now covers the design of concrete and timber highway bridges as well as steel highway bridges. The design of both the superstructure and the substructure of highway bridges is discussed in detail. The treatment covers all the details of constructing highway bridges, including the calculation of the stresses, the design, the estimate, the contract and the erection and construction.

Retaining Walls, Their Design and Construction. By George Paaswell. McGraw-Hill Book Co., Inc., New York. 275 pages, 6x9. $4.

An exposition of retaining wall theory. Modern types of walls are analyzed, and the practical construction problems that confront the engineer are thoroughly discussed. Workable formulas and tables are presented, and a brief but comprehensive treatment of earth pressures and surcharges is included. The wall is discussed in its entirety from the preparation of tho foundation to the ornamental details of the face and coping.

Engineering and Building Foundations. By Charles Evan Fowler. John Wiley & Sons, Inc., New York. 6x9 in., 531 pages. $5.

A revision and amplification of earlier books by the author, presented as the first of three volumes that are to deal with the subject of foundations.

Reinforced Concrete Building Useful Data. By Engineering Staff, Corrugated Bar Co., Inc., Buffalo, N. Y. Leather, 5x8 in. 216 pages. Published by Corrugated Bar Co.

Principles of Reinforced Concrete Construction. By F. E. Turneaure and E. R. Maurer. John Wiley & Sons, Inc., New York. 6x9 in., 485 pages.

This is tho third edition. The book has been revised and contains additional matter.

Estimating Concrete Buildings. By Clayton W. Mayers. Aberthaw Construction Co., Boston, Mass. 6x9 in. 51 pages. $1.

Exposition of method of estimating the quantities in a reinforced concrete building.

Structural Drafting and the Design of Details. By Carlton Thomas Bishop. John Wiley & Sons, Inc., New York. 10x8 in., 352 pages. $5.

Written for the special needs of the structural draftsman.

Handbook of Building Construction. Editors-in-Chief George A. Hool, Nathan C. Johnson. McGraw-Hill Book Co., New York. Two volumes (not sold separately). 1471 pages, 6x9 in., flexible. Per set, $10.

Modern reference data for architects, designing and constructing engineers and contractors. The book covers the design and construction of the principal kinds and types of buildings with their mechanical and electrical equipment. Every detail of practical construction is considered.

Practical Design of Plate Girder Bridges. By H. H. Bird. J. B. Lippincott Co., Philadelphia. $4.

Business:

The Business Man and His Bank. By William H. Kniffin. McGraw-Hill Book Co., Inc., New York. 280 pages, 5½x8 in. $3.

A discussion of banking from the business man's viewpoint, showing him how the bank touches his interests and how he can make full use of the bank's functions. It is based upon the author's many years of experience in mutual savings banks, national and state banks.

Statistics in Business—Their Analysis, Charting and Use. By Horace Secrist. McGraw-Hill Book Co., Inc., New York. 130 pages, 5¼x8 in. $1.75.

The use of statistics in business analysis, showing how and with what effect statistics may be applied in the solution of business problems. The book shows how to gather business facts, how to analyze them, how to classify and tabulate them, how to chart them, how to use percentages, and how to base business policies squarely on business statistics.

Advertising the Technical Product. By Clifford A. Sloan and James D. Mooney. McGraw-Hill Book Co., Inc., New York. 365 pages, 6x9 in. $5.

A common-sense practical discussion of the important phases of the advertising problem that are pertinent to the advertising of the technical product.

Contracts in Engineering. By James I. Tucker. McGraw-Hill Book Co., Inc., New York. Second edition revised and enlarged. [illegible]71 pages, 6x9 in. $4

This book is a primer on the principles of law. It discusses those elementary ideas common to all branches of legal procedure and harmonizes them to bring out those fundamentals which are most important in engineering and general business affairs. The new edition crystallizes that which has been found good in current practice in the writing of engineering contracts. It covers the rapid development in this field in the past few years.

City Manager: City Planning:

New Ideas in the Planning of Cities, Towns and Villages. By John Nolen. American City Bureau, New York. 5x8 in. 138 pages.

A brief outline of city planning.

City Manager in Dayton. By Chester E. Righton. The Macmillan Co., New York. 5x8 in., 271 pages. $2.50.

Descriptive study of the commission manager plan.

Engineering Materials:

Laboratory Manual of Testing Materials. By Wm. K. Hatt, Ph.D., and H. H. Scofield. McGraw-Hill Book Co., Inc., New York. Second edition. 176 pages, 5x7½ in. $2.

A thorough revision of this widely-used manual. The outlines of tests, specifications and related data have been brought strictly up to date. This has been especially necessary in the field of concrete where developments in recent years have been so rapid.

Textbook of the Materials of Engineering. New Second Edition. By Herbert F. Moore; with a chapter on concrete by Harrison F. Gonnerman. McGraw-Hill Book Co., Inc., New York. Second edition. 325 pages, 6x9 in. $3.

A concise elementary presentation of the physical properties of the common materials used in structures and machines. It presents also brief descriptions of their manufacture and fabrication. Though primarily a textbook for a fundamental college course, it should prove of value also to draftsmen, inspectors, machinists, and others who deal with the materials of engineering.

Hydraulics:

Drainage Engineering. By Daniel Wm. Murphy. McGraw-Hill Book Co., Inc., New York. 178 pages, 6x9 in. $2.50.

A general treatise on the drainage of agricultural lands. The book puts into brief but comprehensive form the principles involved in the design and construction of drainage works, and outlines the various questions that affect a drainage problem.

Hydraulic Turbines. By R. L. Daugherty. McGraw-Hill Book Co., Inc., New York. Third edition. 285 pages, 6x9. $3.

A general discussion of waterpower development and considerations affecting turbine operation, the principal features of the construction of modern turbines, the theory and the characteristics of the principal types, commercial constants, means of selection of type and size of turbine, cost of turbines and water power, and comparison with cost of steam power. A chapter on centrifugal pumps is also included.

Dredging Engineering. By F. Lester Simon. McGraw-Hill Book Co., Inc., New York. 182 pages, 6x9 in. $2.50.

A comprehensive treatise covering every phase of the subject. The construction and operation of the principal types of dredges are described in detail. The second half of the book deals with the actual planning and working out of dredging problems.

Practical River and Canal Engineering. By J. R. Battle. J. B. Lippincott Co., Philadelphia. $3.77.

Roads and Streets:

Highway Inspectors' Handbook. By Prevost Hubbard. John Wiley & Sons, Inc., New York. 4x7 in., 372 pages. Written for inspectors, engineers and contractors.

Construction of Roads and Pavements. By T. R. Agg. McGraw-Hill Book Co., Inc., New York. Second Edition. 463 pages, 6x9. $4.

A concise presentation of approved practice in the construction of roads and pavements and of the principles involved. It covers selecting, testing and assembling materials, and incorporating them in the roadway surface. The more important new material in the second edition is that on assessments for pavements; the chapter on Drainage and the control of Erosion; the chapter on Maintenance; the section on proportioning aggregates for concrete roads; and the completely rewritten chapter on Testing Highway Materials.

American Rural Highways. By T. R. Agg. McGraw-Hill Book Co., Inc., New York. 138 pages, 5½x8½ in. $2.

A textbook for agricultural engineers, students in agriculture, and students in extension courses. It points out the relation of highway improvement to national progress and indicates the various problems of highway administration. It describes the usual methods of highway design and construction in sufficient detail to enable the reader to appreciate the distinguishing characteristics and the relative serviceability of each of the common types of roadway surface.

Miscellaneous:

American Civil Engineers' Handbook. Mansfield Merriman, editor-in-chief. John Wiley & Sons, Inc., New York City. 4x7 in. 1,955 pages. $6.

Revised edition containing 375 additional pages.

Earthwork and Its Cost. By Halbert P. Gillette. McGraw-Hill Book Co., Inc., New York. Third edition, 1,346 pages, pocket size, flexible. $6.

This is, in fact, a new handbook of earth excavation. Every phase of such work is carefully analyzed in this book and detailed cost data on every operation are presented. These cost data are so itemized that by proper rate substitutions they may be used by engineers and contractors as cost formulae under all conditions.

Mathematics for Engineers. Part II. By W. N. Rose. E. P. Dutton & Co., New York. 6x9 in. 419 pages. $7.

Intended to occupy a position midway between a theoretical treatise and a practical exposition of the uses of some of the higher mathematics for the every-day problems of engineering work.

Technical Writing. By T. A. Rickard. John Wiley & Sons, New York. 5x8 in. 178 pages. $1.50.

A book designed to be of use to the engineer and the advanced college student.

Topographic Maps and Sketch Mapping. By J. K. Finch. John Wiley & Sons., Inc., New York. 6x9 in. 175 pages. $2.50.

A simple, straightforward treatment of the subject of map reading and the making of simple maps.

Fuel Production and Utilization. By Hugh S. Taylor. D. Van Nostrand Co., New York. 296 pages. 5½x8½ in. $4.

A new treatise on the best approved methods, both English and American, of modern fuel practice, especially written for the man who desires a general survey of the best methods for the most effective and economical utilization of our fuel resources.

Powdered Coal as a Fuel. By C. F. Herington. D. Van Nostrand Co., New York. Second edition revised and enlarged. 338 pages. 6x9 in. $1.50.

The only book published on the subject of powdered coal. It describes the machinery, methods and results of users with figures showing the saving effected by the use of powdered coal as compared with anthracite and bituminous.

Low Grade and Waste Fuels for Power Generation. By John B. C. Kershaw. D. Van Nostrand Co., New York. 202 pages. 5½x8½ in. $1.

The object of this book is to demonstrate how "fuel economy" may be achieved by the use of material now wasted in most plants. It is a discussion of methods proved successful rather than of probabilities.

WEEKLY NEWS SECTION

HALBERT P. GILLETTE, Chief Editor of Engineering and Contracting
(Author of the Handbook of Cost Data for Contractors and Engineers)

For fourteen years this section of *Engineering and Contracting* has been noted for the reliability, freshness and usefulness of its construction and contract news.

ENGINEERING AND CONTRACTING

is the only national weekly periodical published west of New York City that completely covers the field of civil engineering and its allied contracting.

Its subscription price as a weekly is $4.00 a year—or less than 8 cents a week. Although its contract news completely covers the whole civil engineering field every week, its articles are so edited as to cover only one of the four [illegible] each week. [illegible] unique plan and its advantages read the "first line" on the first editorial page.

Bids Asked

Roads-Streets

Ark., Bentonville—[illegible]

La., New Orleans—[illegible]

Mich., Kalamazoo—[illegible]

Mich., White Cloud—[illegible]

Mo., New Madrid—[illegible] New Madrid [illegible]

N. J., Trenton—[illegible]

N. C., Charlotte—[illegible] Charlotte [illegible] on 3-[illegible] with [illegible] set of [illegible] Creswell [illegible]

O., Akron—Until Jan[illegible] for the paving and grading of streets as follows: Betts and Corley, from [illegible] to Market, grading and W[illegible]; [illegible] Case Avenue to end of street, paving and walks; Nevada and Gold Streets, Valley to Silver, paving and walks; Sterer Avenue, Exchange to Jefferson Avenue, paving and walks; and Thayer St., Tallmadge to Hiller, grading and walks. Estimated cost of work, $10[illegible],000. E. A. Zeisloft, Director of Public Service.

S. C., [illegible]—[illegible]

S. C., St. George—[illegible]

Tex., Hamilton—[illegible]

Ont., Toronto—[illegible]

Bridges

Mich., Lansing—[illegible]

N. J., Trenton—[illegible]

Drainage - Irrigation

Calif., Gridley—Until [illegible] of the [illegible] District No. [illegible] for construction of drainage [illegible] constituting [illegible] portion of the drainage system of the said district.

Tex., Houston—Until 10 [illegible] Jan. [illegible] by county commissioners, Harris County Court House, Tex., for construction of drainage improvements, approximately [illegible] cubic yards of excavation in Harris County Drainage District No. [illegible]. [illegible] Howe, Engineer.

Waterworks

[illegible]

La., [illegible]—[illegible]

Wy., [illegible]—[illegible]

Wyo., Douglas—[illegible]

Sewerage - Sanitation

Kan., Emporia—[illegible]

Mich., Detroit—[illegible]

Mich., Detroit—[illegible]

Minn., Duluth—[illegible]

O., Cleveland—Until noon, Jan. [illegible] for the construction of the [illegible] Sewer No. 21[illegible] in Sawyer Ave. [illegible] from East [illegible]th Street to [illegible] Street.

Ohio, Hamilton—Until noon, Jan. [illegible], by Mr. F. J. [illegible], Director of Public Service, for furnishing necessary labor and material for the improvement of the following streets: Black, B street, Gordon avenue, [illegible] avenue, Prytania avenue, [illegible], Edgelawn avenue, Cleveland avenue, E street, F street, Progress avenue, Sherman avenue, Sumner avenue, [illegible] avenue, Warwick avenue, High-

[illegible] with [illegible] contractor and [illegible]

Buildings

Ariz., Phoenix—[illegible]

Ariz., Phoenix—[illegible] N. Mex.

Fla., Pensacola—[illegible] Trinity [illegible] Pensacola, Fla.

Mass., Newton—[illegible] Auburn and Wood [illegible]

Mass., Newton—[illegible] Fire Station to be [illegible] Auburn and Woodland [illegible] Auburndale.

Mass., West Newton—Until 2 p. m., [illegible] by the Public Buildings Commissioner, [illegible] West Newton for [illegible] material and labor except heating and [illegible] to erect a new Fire Station at the corner of Auburn and Woodland Streets, Auburndale. James H. [illegible] Architect, Boston, Mass.

Miss., Rosedale—Until 2 p. m., Jan. 1st, by the Trustees of the Rosedale Consolidated School for the erection of a school [illegible] to be erected in the town of Rosedale, [illegible] Architect; [illegible] Associates, 704 Randolph Bldg., Memphis, Tenn.

Ind., Crown Point—Until 2 p. m. Jan. 15 by Trustee of the Barkley Twp., Jasper County, at the Blackford school house, District No. 6 in said township, for the erection and completion of two 4-room school buildings; estimated cost [illegible]; one to be erected at Newland and the other about two miles west of Moody. [illegible] Smith, Architect, Crown Point, Ind.

Kan., Emporia—Until Jan. 11 by County [illegible] for construction of a new county hospital. Approximate cost of buildings, [illegible].

Mich., Detroit—Bid will be readvertised Jan. 7 by the Board of Education for furnishing labor and material for the erection of the Cass Technical High School building to be located on the northwest corner of Second avenue and High street. [illegible] & McCall, Engineers, 2348 Penobscot Bldg.

N. Y., New York City—Until 11 a. m. [illegible] by Henry H. Curran, President of the Borough of Manhattan, at Room 2031 Municipal Bldg., for furnishing labor and [illegible] for alterations and repairs to the [illegible] West 17th [illegible] Manhattan.

N. Y., New York City—[illegible] 11 a. m., [illegible] by President of the Borough of [illegible] Municipal Building, [illegible] for alterations [illegible] to the public building, [illegible] West [illegible] Street, Borough of Manhattan.

O., Cleveland—Until noon, Dec. 30, at [illegible] commissioner of purchases, Room 219 City Hall for constructing [illegible] Lincoln Park bath house at the corner of Starkweather and W. 14th [illegible]

Pa., Oxford—Until Jan. [illegible] by Fulson and [illegible] Architects, of Philadelphia, for [illegible] memorial gateway at Oxford [illegible] for the Lincoln University.

Pa., Pittsburgh—Until Jan. 3 by Architect [illegible] Windrim of Philadelphia, [illegible] office building at Pittsburgh, [illegible] for the Bell Telephone Co.

Tenn., Knoxville—Until 3 p. m., Jan. 5 by [illegible] A. Wetmore, Acting Supervising Architect, Treasury Department, Washington, for new lookout gallery, etc., in the United States Post Office.

Rivers - Harbors

Ark., Texarkana—Until [illegible] p. m., Jan. 8, by the Board of Directors of Miller Levee District No. 2, for the following work: Section 1, New Levee, 164,000 cu. yds., ditch 9,500 cubic yards, Section 2 Levee Enlargement 575,000 cubic yards. C. S. Christ[illegible]n, Chief Engineer.

Ind., Fort Wayne—Bids will be readvertised until 7:30 p. m., Jan. 13, 1921, by the Board of Public Works, for the construction of a concrete wall and concrete slabs [illegible] along west side of Mechanic Street and the east bank of the St. Mary's River extending north and south from the foot bridge crossing St. Mary's River at Elm Street. F. G. Wyenken, Clerk.

N. Y., New York City—Until noon, Dec. 31, by Commissioners of Docks, Pier A, foot of Battery place, North River, for furnishing labor and material for dredging in the Boroughs of Manhattan and Brooklyn.

Ohio, Cincinnati—Until 10 a. m. Jan. 20, 1921 at U. S. Engineer Office, 2nd District, Cincinnati, Ohio, for constructing or fabricating ready for constructing, steel hull, for snag boat "Kentucky." W. P. Stokey, Lt. Col., Engrs. (Advertisement in this issue.)

Va., Wheeling—Until 11 a. m., Jan. 22, by United States Engineer at Wheeling, W. Va., for furnishing and delivering forged steel and cast iron wheels for gates and structural steel, for gate tracks, for Dam No. 11, Ohio River.

W. Va., Wheeling—Until 11 a. m., Jan. 22 by U. S. Engineer Office, Wheeling, W. Va., for furnishing and delivering forged steel and cast iron wheels for gates and structural steel for gate tracks for Dam No. 11, Ohio River. (Advertisement in this issue.)

Power Plants

D. C., Washington—Until 11 a. m., Jan. 7th, at office of the Depot Quartermaster, 17th and F Sts. N. W. Washington, D. C., for the construction of 75 foot iron flagstaff, at Seven Pines National Cemetery, Richmond, Va.

N. Y., New York City—Until 11 a. m., Dec. 31, by Commissioners of WaterSupply, Gas and Electricity, Room 2351 Municipal Building, Manhattan, for furnishing and maintaining electric lighting units for lighting public streets, parks and places, for furnishing electric current for light and power in certain buildings and for furnishing and maintaining certain equipment from Jan. 1, 1921, to Dec 21, 1921; for performing sundry repair and other works to lighting equipment furnished by the city during said period.

N. Y., New York City—Until noon, Jan. 5, by Supt. of School Building, the Board of Education of the School District, City of New York, Room 2800, Municipal Building, Manhattan, for installing Electric Equipment in new public schools, 38, on St. Ann's Avenue, Rae St., Carr St. and Hagney Place, Borough of the Bronx.

N. Y., New York City—Until 11 a. m., Dec. 31, by Commissioner of Water Supplies, Gas and Electricity, Room 2351, Municipal Building, Manhattan, Boroughs of Manhattan, the Bronx, Queens and Richmond, for furnishing and maintaining electric lighting units for lighting public streets, parks and places, Boroughs of Manhattan, the Bronx, Queens, and Richmond, for supplying gas to public buildings, offices, structures, Borough of Manhattan for reserving and furnishing electric generating capacity, current and equipment for use of the high pressure fire service pumping stations for the year 1921. For furnishing electric current for light and power, to the Board of Inebriety building, Inebriates Farm, Warwick, New York, and such other buildings in Orange County as a commissioner may direct, from Jan. 1, 1921, to Dec. 31, 1921, for furnishing electric current for light and power to the buildings on the grounds and other tuberculosis sanitariums of the department of Health at Otisville, Town of Mount Hope, Orange County.

O., Columbus—Until noon, Jan. 12th, by Board of Purchase, for one Dual drive exciter set

Miscellaneous

N. J., Elizabeth—Until noon, Jan. 3, at office of the Union County Mosquito Extermination Commission, 25 Railway Avenue, for furnishing one Ford one-ton chassis.

N. Y., New York City—Until 10:30 a. m., Dec. 30, by Board of Purchase, at Room 526, Municipal Bldg., Manhattan, for furnishing and delivering gasoline motor driven aerial hook and ladder trucks to the fire department.

O., Columbus—Until noon, Jan. 5th, by W. H. Duffy, President of the Board of Purchase of City Hall, for furnishing and delivering one five-passenger sedan automobile for the division of water, f. o. b. Columbus, Ohio.

Wash., Seattle—Until 9 a. m., Dec. 30, by R. W. Jones, secretary of Seattle District No. 1, for furnishing and installing elevators in district warehouse and shops.

Wis., West Allis—Until Jan. 3 by the Fire and Police Commission for fire engine service and ladder truck for the fire department.

Prospective Work

Railways

Ariz., Phoenix—[illegible] Arizona South[illegible]

D. C., Washington—[illegible] Commerce [illegible] a loan of $[illegible] New York Central and seven sub[illegible] equipment and additions and betterments which will involve a total cost of $56,625,000.

D. C., Washington—The Central of Georgia Railway Company plans to build a coal line 6.78 miles long in Jefferson County, Alabama, to the lower Cahaba coal fields.

D. C., Washington—The Chicago & Eastern Illinois R. R. Co. applied to the Interstate Commerce Commission for authority to take over the Chicago & Eastern Illinois Railroad Co., reorganize it and issue bonds to the amount of approximately $60,000,000. It is planned to purchase new equipment, make additions and betterments to said road.

Ill., Chicago—The Wisconsin & Michigan Railroad Co., with headquarters in Chicago, has been authorized by the Interstate Commerce Commission to build and operate 7.17 miles of railroad between the Faithorn Junction and the Aragon Junction, Mich. John March, President of the company.

Ind., Fort Wayne—Board of Works approved contract between the city and the Indiana Service Corporation for the installation of a new street car line in the Ninth Ward.

Mass., Greenville—Change and improvements are to be made to the Greenville

PLYMOUTH

Gasoline Locomotives

PIONEERS
IN
DEVELOPMENT

•••••

PACEMAKERS
IN
PRODUCTION

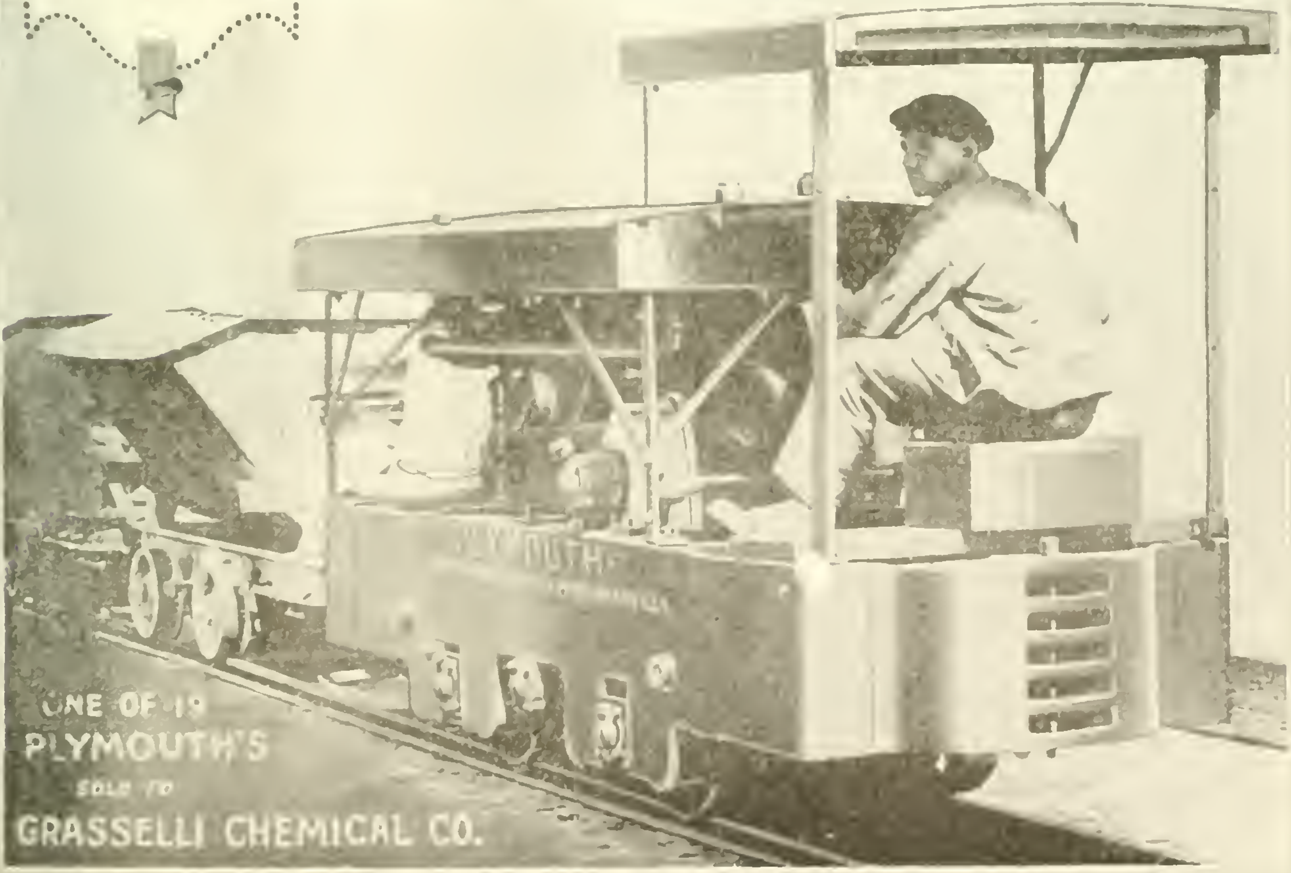
•••••

COLOR BEARERS
IN
SERVICE

For a quarter of a century the PLYMOUTH GASOLINE LOCOMOTIVE has been first aid to men burdened with haulage problems. It has power above our rated guarantee. It displaces slow teams. Cuts down the man force. Multiplies haulage capacity. Shortens the period of contract. Lessens the pay roll. Increases the profit.

A mile of track costs no more than one road truck. Over this track the PLYMOUTH will haul, hour for hour, as much as twenty trucks. Write for Bulletins that inform you fully.

THE FATE-ROOT-HEATH COMPANY
205 Riggs Avenue PLYMOUTH, OHIO



ONE OF 19 PLYMOUTH'S SOLD TO GRASSELLI CHEMICAL CO.

street railway system recently taken over by the city.

Mass., Quincy—[illegible] F. Crewe [illegible] Quincy awarded contract for [illegible] the Quincy [illegible] stations by [illegible] grade crossings in this city and extending the four track system to Braintree.

Mich., Detroit—Street Railway Commission will award contract for furnishing cross arms to J. Alexander Navarre [illegible] [illegible] 2-pin, [illegible] 4-pin, 700 6-pin, and [illegible] 8-pin cross arms at a price of $[illegible] $97.[illegible] $1[illegible] and $1[illegible] per 100 respectively. Contract for cable awarded to the American Steel & Wire Co. for 1,[illegible] C. M. cable at $17.50 per cwt.

N. Y., New York City—The Pennsylvania Railroad awarded contract for 200,000 tons of rails at $47 a ton. Illinois Steel Company [illegible] tons, Carnegie Steel Company, 60,000 tons, Bethlehem Steel and Midvale Steel and Ordinance Company, 45,000 tons each, and Lackawanna Steel 10,000 tons.

O., Cincinnati—Cincinnati Traction Co. will spend $992,000 for improvements, including extension of Warsaw Ave. line to Coveleigh, remodeling car barns, relaying of track on streets to be improved by the city, etc.

Tex., Amarillo—Fort Worth and Denver City Railroad will make improvements at Amarillo including a turntable, extensions of power plant and new machinery at a cost of $100,000. Similar improvements at Wichita Falls will cost about the same amount, and at Texline about $40,000.

Tex., Childress—The Fort Worth and Denver City Railroad will spend $100,000 for improvements at Childress; $200,000 for yard extensions and $300,000 for enlargement of shops.

Ont., London—City Council will ask Grand Trunk R. R. to proceed with track elevation at once.

Roads-Streets

Ariz., Gilbert—City considers the purchase of a street sprinkler.

Calif., Colusa—Bonds were voted by the owners of lands in Reclamation District No. 1,004, embracing lands in Colusa County, on the eastern side of the Sacramento River, in the amount of $770,000. The proceeds from the bond sale will be used to pay for work already completed, extensions and improvements.

Calif., Los Angeles—Work will soon begin for the improvement of West First St., including widening, grading, paving and transforming it into one of the great major thoroughfares of the city, according to City Engineer Griffin. The new highway will link up the center of Los Angeles with portions of the city as far west as the limits of Beverly Hills. Estimated cost of improvements, $1,121,168.

Calif., Stockton—A budget of approximately $1,023,806 for municipal expenditures in 1921 was passed by the Council. City plans an extensive program of street improvements and repairs, construction of rainwater sewers and south sewerage outfall, construction of bridges, culverts and sidewalks, pumping plant, garbage disposal, lighting.

Calif., Susanville—Board of Supervisors ordered the County Engineer to prepare estimates and plans for eliminating the dangerous crossings to the town known as the Brockman crossing.

Colo., Denver—This city plans federal aid improvement and construction of 13 miles of concrete highway in Larimer County, between Fort Collins and Loveland. Estimated total cost of improvements, $57,965.

Fla., Jacksonville—All bids rejected by the Board of County Commissioners of Duval County for stumping, grubbing and clearing of approximately 2 miles of right of way 30 ft. wide, on road known as the Bryan Road. Frank Brown, Clerk.

Fla., Tallahassee—Bids will be readvertised soon by State Roads Department for the improvement and completion of a section of State Road No. 1, 9.9 miles. Chas. A. Browne, State Highway Engineer.

Ga., Moultrie—Officials in this city will resume work for the road paving program of Colquitt County. Approximately $500,000 will be expended for the improvement of road.

Ill., East Moline—Bids will be readvertised by the Board of Local Improvement [illegible] paving project [illegible] cost $[illegible].

Ill., Joliet—A link between Joliet and [illegible] Street and Jefferson and Washington streets will be paved at an estimated cost of $5,711.

Ill., Peoria—Members of the Board of [illegible] passed a resolution authorizing an appropriation of $30,000 for the [illegible] of Knoxville road from Corrington [illegible] the Implement Fair Grounds, a [illegible] of nearly a mile.

Ill., Springfield—The Lakes to the Gulf [illegible] Highway Association which will [illegible] a trail from Chicago to Brownsville, Tex., was granted a charter by the Secretary of State Emmerson. The headquarters of the concern is in the Chamber of Commerce building Springfield, Ill. A. L. Carter, interested in project.

Ind., Fort Wayne—Council passed resolutions for sidewalks on both sides of Fairfield avenue, from Rudisill boulevard to Hilda drive. Assessment rolls have been confirmed for the paving of Meridian street, Barr street, Garden street, Van Buren street and Brandiff street.

Ind., Kendallville—State Highway Commission plans the following road work in 1921: LaGrange County, completion of work started on road south of LaGrange; Steuben County, completion of road east of Angola to Ohio state line; DeKalb County, completion of road north of Waterloo to Angola; Noble County, paving of Brimfield road.

Ia., Clinton—A petition is being circulated by citizens on Bluff Blvd., asking that the boulevard be paved from the end of the present brick pavement to the city limits.

Kans., Emporia—Contract will be let soon by the County Clerk for the construction of 5 miles of concrete road on the new Santa Fe Trail.

Mass., Boston—City Planning Board approved the project for widening in Cambridge St.

Mo., Piedmont—It is planned to construct 15 miles of state highway from Piedmont to Silva at a cost of about $203,000. A state and federal project.

Nebr., Nebraska City—City Commission plans to complete the South Side paving contract started two years ago.

N. Y., Binghamton—Resolutions were adopted by the Broome County Board of Supervisors this morning authorizing the County Treasurer to borrow $60,000 for use in highway construction for the coming year, and for the purchase of a steam shovel to be used in county work.

N. J., Elizabeth—Union County plans an extensive road building program for 1921. County's budget appropriations approved by the Board of Freeholders total $1,333,403.

N. J., Newark—Hudson County Board of Commissioners considers the purchase of a $500,000 snow tractor from the Holt Manufacturing Company at 50 Church Street, N. Y.

N. J., Trenton—State Highway Commission made annual apportionment of the Motor Vehicle Funds to the 21 counties for the maintenance of roads: Middlesex county to receive $125,000 and Monmouth County gets $110,000, and Somerset County $60,000.

N. J., Trenton—Twp. Committee passed ordinance for sidewalks in North Lehigh Avenue.

O., Akron—Akron Street Improvement program for 1921 will start January 18th.

O., Middletown—City Commission plans the widening of sidewalks on East Third St., from the Hydraulic Race to the Miami and Erie Canal bridge. It is planned to pave this street and other streets, remove overhead wire on Third Street and install ornamental lighting systems.

Ohio, Youngstown—The City Planning Commission contemplates the widening of the following streets: Andres avenue, Belmont avenue, Lincoln avenue, Glenwood avenue, Market street, Manning avenue, Oak street, Rayen avenue, Wick avenue, Warren avenue and Watt street.

Pa., Beaver—Beaver County road program for 1921 calls for the construction of 13 miles at an average cost of from $55,000 to $60,000 a mile, or an aggregate of nearly $780,000.

Pa., Harrisburg—State Highway Department plans for 1921 call for completion of 250 miles of concrete road, with building of 350 miles additional road.

Pa., Phillipsburg—The State Highway Commission passed a resolution authorizing the Warren County Board of Freeholders to proceed with the construction of the Washington-Phillipsburg road and setting aside $600,000 from the 1922 road funds for the purpose.

Pa., Williamsport—City will expend $75,420 for curbing and paving of streets. Department of Parks and Public Buildings received an appropriation of $10,000, most of which will be used for taking over and improving the Lycoming fair grounds playground site.

S. C., Greenwood—Municipal 6 per cent bonds totaling $200,000 recently sold here will be used for extending street paving and sewers.

Tenn., Knoxville—City considers resurfacing and repairing several streets with Kentucky Rock Asphalt at an estimated cost of between $1.70 and $2 per square yard.

Tenn., Nashville—Tennessee will receive $2,000,000 for highway development work, according to State Highway officials.

Tex., Beaumont—Citizens voted in favor of a bond issue to provide for street and highway improvements to cost $350,000.

Tex., Houston — Council instructed the City Attorney to draw a resolution providing for the paving of Travis street from the north line of Rusk avenue to the south line of Polk avenue.

Tex., Houston—The City Council adopted plans and specifications for graveling the following streets: Elysian, from Brooke to Loraine; Thomas, from Winne to Paschal; Morris, from Churchill to Quitman; Carl, from Fletcher to Thomas; Northwood, from Pecore to Houston Heights avenue; Common, from Harrington to Jones; Hickory, from Winter to Dart; Palmer, from Franklin avenue to Congress avenue and Beauchamp.

Tex., Texarkana—A good road bond issue of $35,000 in Precinct 7, Cass County.

Wash., Port Orchard—All bids were rejected by the Board of County Commissioners of Kitsap County for clearing, grubbing, graveling, grading, building culverts and drainage work on roads in Sections 10 and 15, Twp. 24, Project No. 13, Charlestown to Finney Bay.

W. Va., Charles Town—Plans for federal aid road project in Pleasants county were approved by B. E. Gray, senior federal highway engineer. Estimated cost $27,000.

Ont., Toronto — Council appropriated $100,000 for park improvements.

Wis., Milwaukee—The 1921 budget provides for $200,000 for Lake Shore Drive and $800,000 for street opening.

Wis., Milwaukee—The Board of Estimates approved a bond issue of $800,000 requested by the land commission for the opening and widening of streets.

Wyo., Basin—The Big Horn Canal Association will spend $40,000 in 1921 in permanent concrete improvements and finishing reconstruction program started in 1915.

Ont., Ford City—Local Improvement Commissioner will involve an expenditure of $52,604.

Bridges

Conn., Hartford—Public Utilities Commission approved plans of Robert Gair & Co., Montville, for construction of steel foot bridge over the tracks of the Central Vermont Railway Co. Bridge will be 278.8 feet long and 8 feet wide.

Ind., Indianapolis—Frank C. Ligenfelter, city engineer, recommended to the Board of County Commissioners construction of a concrete arch bridge to replace the Kentucky avenue bridge over White River.

Kans., Wichita—The city manager, L. W. Clap, received blue prints showing plans of the proposed Waterman street viaduct under the tracks of the Wichita Union Railway company. Work to be completed before the end of 1921. Estimated cost of improvements $110,485.

La., Baton Rouge—The Louisiana R. R. Commission ordered the Louisville & Nashville R. R. Co. to rebuild bridges over the Rigolets and Chef Menteur, construction work to begin by July 1, 1921.

Mich., Detroit—Work will start soon for the construction of the new international bridge to span the Detroit River and connect Windsor and Detroit. Charles Evans Fowler estimates cost about $25,000,000.

Mich., Detroit—All bids were rejected by commissioners of public works for the construction of new Belle Isle bridge.

Minn., Duluth—City will appropriate $10,000 for the construction of a culvert and fill at Central Ave. and Polk St.

A Big Time-Saver

THE speedy Cletrac saves time at every turn. It cuts costs all along the line—moves cars and machinery, hauls wagons and trailers over rough footing and up steep grades and keeps dirt moving from the excavation in a steady stream.

Two broad metal tracks carry the sturdy Cletrac and its heavy loads over soft and icy ground—with plenty of pull for the pinch. Its small size and 6 ft. turning radius make it easy to handle—a fast worker in cramped quarters.

Hustles your belt jobs, too. Lines up quickly—stays lined up—and its 20 H. P. readily operates your concrete mixers, pumps and similar equipment.

Now's the right time to order Cletracs for your spring and summer work. Each Cletrac replaces two to four teams, works all year 'round, and lessens the labor crew. See the Cletrac dealer near you or write to us for full particulars.

The Cleveland Tractor Co.

Largest Producers of Tank-Type Tractors in the World

19191 Euclid Avenue Cleveland, Ohio

N. J., Elizabeth—All bids were rejected by the Board of Chosen Freeholders of Union County for new lift bridge of the Strauss Trunnion Bascule Type over the Elizabeth River at South Front St.

N. J., Trenton—Work will start at once by the Pennsylvania Railroad Co. for the new steel-work concrete bridge at Prospect St. Approximate cost of bridge and approaches is $[illegible]. The street will then be widened and improved. Improvements will involve $[illegible].

O., Akron—City of Akron considers the construction of a viaduct between West and North Akron.

Ohio, Columbus—Council asked estimates and plans for the erection of a viaduct connecting Third street with Sunset [illegible].

Ohio, Niles—Commissioners of Trumbull County will sell bonds of $20,000 to provide for the construction of the approaches to the New McDonald bridge.

O., Sandusky—Kelley Island Lime and Transportation Co. purchased the Toledo, Port Clinton & Lakeside electric line from the Northern Ohio Light and Power Co. and will start at once building a bridge over Sandusky Bay.

Tenn., Knoxville—Reflooring the Tennessee River bridge with creosote blocks will be started by Commissioner J. Lloyd McCallum's department next spring. Approximate cost $[illegible].

Wis., Milwaukee—The 1921 budget provides for a bond issue of $100,000 for bridges and viaducts.

Wash., Seattle—City Architect Daniel Huntington is preparing plans for the construction of the Montake avenue bridge.

Man., Brandon—A new bridge will be built soon over the Snye River. City Engineer instructed to secure estimates for cement or steel structure.

Drainage - Irrigation

Calif., Modesto—Work will begin soon for the construction on the Don Pedro dam. More than $5,000,000 in bonds were voted by the Modesto and Turlock District last spring.

Calif., Redding—The Happy Valley Irrigation District will vote Jan. 15th on a bond issue of $150,000 for improvements.

Calif., Redding—Directors of the Anderson Cottonwood Irrigation District, rejected all bids for the construction work calling for an expenditure of approximately $100,000.

Calif., Sacramento—Improvements for Reclamation District No. 70, located in Sutter County will involve an expenditure of approximately $300,000. Fred H. Tibbits, Engineer.

Colo., Denver—A new irrigation system to provide water for 22,000 acres, Northeast of Craig, is contemplated by the city.

Md., Easton—E. G. Kastenhuber, Jr. has completed a survey of the swamp lands through which it is proposed to build a reclamation ditch; 5,670 acres will be drained.

Ore., Portland—An appropriation of $400,000 for the Deschutes Irrigation Project in Jefferson, Crook and Deschutes Counties, Oregon, involving the irrigation of 200,000 acres of land has been approved by Sec'y Jno Barton Payne.

Tex., Houston—No bids received Dec 13 by H. L. Washburn, County Auditor, for work on Poor Farm Ditch.

Wash., Prosser—A survey is being made for the construction of a canal for the Yakima-Benton Irrigation District.

Board of Directors of Walker River Irrigation District have taken steps to secure the natural reservoir site at Toll House near Bridgeport in connection with project of watering tract of land on the east fork of Walker River.

Waterworks

Calif., Orland—Citizens approved a bond issue of $[illegible] for the purchase of an auxiliary oil burning engine and other equipment for the municipal water system.

Ill., Mt. Sterling—Citizens will vote on the question of issuing bonds of $15,000 for improving the pumping system and also on [illegible] two deep wells that were drilled during the past summer.

Mo., Kansas City—Mayor and members of the Fire and Water Board approved recommendations by the Board of Review for improvements of the water works system.

Neb., Tecumseh—Citizens will vote January 18th on a bond issue of $25,000 for extending the water mains, installing a filtering or purifying plant.

N. J., Hopewell—City considers the improvement of the water pumping system.

N. J., Metuchen—The Middlesex Water Company may improve the water supply of [illegible].

O., Lisbon—The town pump and five deep water wells in this municipality have been condemned by the State Board of Health and improvements made. Dr. W. H. Dittoe, Chief Sanitary Engr. of [illegible].

Tex., Beaumont—A bond issue was voted in this city to provide for waterworks extension to cost $350,000.

Tex., Hallettsville—A bond issue of $20,000 was approved in this city for rehabilitating water works and lighting plant.

Sewerage - Sanitation

Calif., Los Angeles—Board of Public Works will advertise for bids for three screens to be used at new Terminal Island sewage disposal plant. Estimated cost about $2,000.

Ill., Joliet—Residents of Mapleborough and Belmont subdivisions organized a club for the purpose of obtaining improvements. The community program includes plan for disposal of garbage, installation of sewerage system, extension of water service, extension of electric service and street car service. Walter Hogreff, Pres. of the organization.

Mo., Kansas City—Work of straightening, deepening and widening the channel of Turkey Creek through Rosedale, to begin immediately after January 1st, according to L. R. Gates, city attorney. Estimated cost $126,000.

N. J., Newark—The Building Committee of the Board of Freeholders decided upon the construction of an additional sewer line to accommodate the new buildings under construction at the Essex Mountain Sanatorium, Verona. County Engineer Reimer will submit plans and advertise for bids. Estimated cost $15,800.

N. J., Trenton—Residents of Broad Street Park have decided upon the construction of a drainage district to cost $142,500. Chas. S. Sincerbeaux, Civil Engineer.

O., Struthers—Council passed resolutions providing for construction of storm water and sanitary sewers on the north side of the river.

O., Toledo—A plan for motorizing the garbage division is being considered by city.

Pa., Erie—Council will authorize the construction of a sewer in 20th St. from Prairie to Wallace and Third South in Wallace St., 155 feet from 20th St. Estimated cost, $3,500.

Pa., Williamsport—Council approved a bond issue of $185,000. Sewerage improvements will cost the city $59,580.

S. Dak., Elk Point—City plans the construction of sanitary sewer system to cost $55,000 and disposal plant at $15,000. K. H. Johnson of Sioux City, City Engineer of Elk Point.

Tex., Beaumont—Citizens authorized an expenditure of $200,000 for sewerage improvements.

Va., Roanoke—City Council sold $650,000 worth of Sewer and Drain Bonds for the purpose of making improvements.

W. Va., Spencer—Sewerage and waterworks improvements are contemplated for town of Spencer, Roane County.

Wis., Milwaukee—1921 budget approved by the Board of Estimates includes a bond issue of $2,200,000 for sewers.

Buildings

Ala., Birmingham—Plans will be prepared soon for the city's proposed half million dollar auditorium by the American Institute of Architects. Hugh Martin, of Miller and Martin, will be in charge of the work.

Ariz., Phoenix—Board of Education contemplates erection of five new structures.

Calif., Berkley—It is proposed to erect a million dollar stadium as a home for athletics at the University of California. David P. Barrows, President of the University.

Calif., Pasadena—Enlargement of the John Muir Intermediate School was authorized by the Pasadena School Board.

Calif., Richmond—Masons of Richmond will erect a business and lodge building in 1921.

Calif., Richmond—City will erect an auditorium in 1921 as a war hero memorial.

Calif., Sacramento—The Commercial Club will spend $125,000 in enlarging and improving its quarters on the two top floors of the Merchants Exchange.

Calif., Sacramento—The Finance Committee recommended the Chamber of Commerce the construction of a $65,000 home at Seventh street, I and J streets.

Calif., Sacramento—The Saco Valley Meat Canning and Provision Company will erect a plant at once. C. C. Cuff, architect.

Calif., San Francisco—Reid Bros., Inc., will erect a large factory in San Francisco, first until will cost $250,000. The San Francisco dam of the company is now at 91 Drumm street.

Calif., Vallejo—Construction work will begin in January for the erection of a new high school to cost $250,000. W. H. Weeks, of San Francisco, Architect.

Calif., Willows—Citizens will vote Jan. 15 on a bond issue of $160,000 for the erection of the Willows Grammar School. W. H. Weeks, Architect.

Colo., Delta—A concrete products factory, being a combination of the Uncompahgre Valley Cement State Silo Company and other industries, will be established in this city; $60,000 will be expended for the erection of a plant.

Del., Lewes—Special School District of Lewes is to have a new Central School Building, approximate cost building, equipment and grounds $250,000. Prof. H. S Rausch Superintendent of Schools.

Fla., Jacksonville—It is planned to establish a factory to build boats and propellers. F E. Hewitt, general manager of the Disappearing Propeller Boat Co. of Detroit, in charge of project.

Ill., Chicago—Work will start Jan. 1 on the erection of 100 bungalows on the northwest side, on Addison St., east of Central Ave. Niels Buck, Architect.

Ill., Chicago—Illinois General Hospital purchased property of the Woman's Hospital of Chicago, 460 East 32d street, and will erect a $1,000,000 hospital.

Ill., Chicago—According to Albert I. Doerr, manager of the Wilson Avenue Arcade Company, it is planned to construct a $130,000 arcade containing 48 shops, on Wilson avenue.

Ill., Chicago—Work will begin in January on a $700,000 apartment hotel for Streeterville on the De Witt court facing west, extending from Delaware place to Chestnut street. Henry J. Schlacks, architect.

Ill., Chicago—Plans have been prepared for $560,000 additional buildings for the By-Products Coke Corporation at its plant at 112th street and Torrence avenue. Ernest McCullough of Syracuse, N. Y., architect.

Ill., Chicago—The A-B Polish Company will construct additions and alterations to its plant at 1515 Haddon avenue, near Milwaukee avenue, to cost approximately $42,000. G. E. Pearson, architect.

Ill., Chillicothe—The school trustees of the Chillicothe twp. plan the erection of a high school building at the corner of Sixth and Hickory streets.

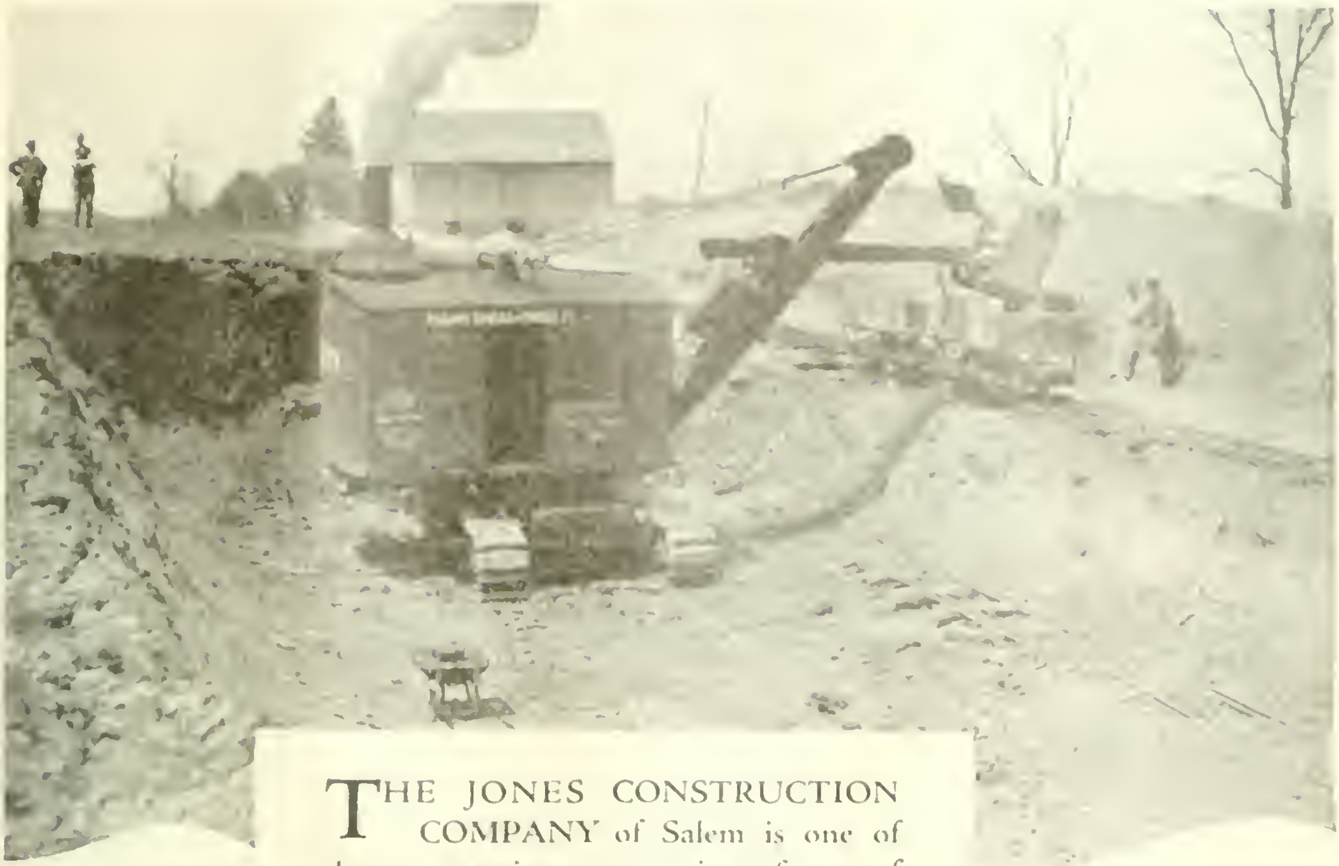
Ill., Springfield—The Sheridan Apartment Hotel Co. and the Apartment Securities Corp. plans the erection of a $1,900,000 apartment hotel in Springfield. Chicago capital is backing the concern. E. R. Davy, Loan Wenters, and D. W. Newton, incorporators.

Ind., Indianapolis—Board of Park Commissioners ordered specifications prepared and bids received for a standard swimming pool and shelter house. James H. Lawry, supt. of parks. Estimated cost $12,000.

Ia., Marshalltown—Dunbar district, including territory in Marshall and Tama counties voted in favor of a bond issue of $60,000 for a school building.

Ia., Oelwein—The Sinclair Refining Co. will erect two oil storage tanks and a concrete and steel warehouse for oils and grease, to be located on the corner of Frst Ave. and Second St., S.

Ia., Ottumwa—It is contemplated to erect a 10-story hotel on the site of the present Ballingall Hotel. Mr. Chas. A. Well-



THE JONES CONSTRUCTION COMPANY of Salem is one of the progressive contracting firms of Northeastern Ohio. On their operations you will always find modern, up-to-date machinery working steadily and efficiently.

"Marions" have been their approved choice for all kinds of excavations. This Model 21 is their seventh "Marion" and two more will soon be in operation, making nine in all.

Repeat orders always carry with them the high testimonial of complete satisfaction. Write us for the names of some "Marion" users near you, get their ideas at first hand and ask them all the questions you wish.

THE Marion STEAM SHOVEL CO.

Established 1884 Marion, Ohio

New York Chicago Atlanta San Francisco

Boise, Idaho, - [illegible] Equipment Co.
Billings, Mont., - F. B. [illegible] Co.
Dallas, - F. B. Wright, [illegible] Bldg.
Denver, - - - H. W. Moore & Co.
Detroit, W. H. Anderson T. & S. Co.
Philadelphia, H. L. Cox, 13 [illegible] Cherry
Pittsburgh, - - - J. W. Patterson
Portland, - - Clyde Equipment Co.
Salt Lake City, H. W. Moore & Co.
Seattle, - - Clyde Equipment Co.
Vancouver, - - - - - - - Vancouver Machinery Depot, Ltd.
Montreal, Toronto, - - - - - F. H. Hopkins & Co., Ltd.

man, executor and trustee of the estate of P. G. Ballingall, deceased Phoenix Trust building, Ottumwa, Ia.

Ia., Waterville—Town of Waterville [illegible] to have a new consolidated school building. Work of construction will begin in the spring. Carl F. Saam of Dubuque, architect.

Kas., Hays—The Methodist Episcopal church of Hays has planned $275,000 for the construction of a new church and home.

Kan., Kansas City—Construction of the proposed $250,000 Labor Temple will start in the spring according to T. A. Flynn, Park Commissioner.

Kans., Wichita—Work will begin about March 1st for the construction of an $800,000 Orpheum theater at Lawrence avenue and First street.

La., New Orleans—Construction work on the one million Celo-tex factory will be started soon in Jefferson Parish. B. G. Dahlberg of Minneapolis, Minn., head of project.

La., New Orleans—According to T. P. Bell of the City Board of Missions, the Methodists contemplate the erection of a building with swimming pool, gymnasium and medical clinics to be located at North Rampart and Governor Nicholas, at a cost of $100,000.

La., New Orleans—According to T. P. Bell of the City Board of Missions, work on erecting a neighborhood house at North Rampart and Governor Nicholls Sts. will begin soon. More than $100,000 has already been appropriated.

La., New Orleans—City and Dock Board plans to purchase a new steel fire fighting tug to patrol the river front. Estimated cost $200,000.

Md., Baltimore—Plans are being prepared by William H. Emory for the erection of a one story building for Martin McDukehart & Co., at Race and McComas Sts. Plans include foundry and machine ship. Estimated cost, $30,000.

Minn., Crosby—Plans are being prepared by Architect H. S. Swenson of Crosby for the erection of a Swedish Lutheran Church in said city.

Minn., Hackensack—It is planned to erect a new school in this city at a cost of $150,000. F. R. Ross, Clerk of the School Board.

Miss., Jackson — The Chess-Wymand Company, barrel and stave manufacturers, will erect an up-to-date finishing mill.

Miss., Yazoo City—Plans have been completed by N. W. Overstreet of Jackson, Miss., for the new building for the Yazoo Sanitarium.

Mo., Columbia—The State University of Columbia will ask for an appropriation of $1,000,000 for 1921 and 1922. Many new improvements and additional buildings are contemplated for the university.

Mo., Columbia—St. Louis syndicate purchased Columbia Gas and Coke Co. and will spend $25,000 for improvements at once. Thomas D. Miller, St. Louis, interested in project.

Mont., Helena—Bonds totaling $1,750,000 will be sold immediately and the proceeds devoted to improving, equipping and adding new buildings to Montana State schools and institutions. Allocation of this fund is: State University of Missoula, $600,000. Agricultural College, Bozeman, $600,000; School of Mines, Butte, $250,000; Normal School, Dillon, $25,000, Orphans' Home, Twin Bridges, $75,000; Deaf and Blind School, Boulder, $75,000, Girls' Vocational School, Helena, $75,000, Industrial School, Miles City, $50,000.

N. H., Keene—The State Board of Education recommended to the legislature the erection of a dormitory for the Keene Normal school.

N. H., Manchester—According to Stanley S. James, manager of the Park Players, a new Orpheum theatre which will be a big addition to the Queen City's amusement houses, will be erected on Lowell St. on the present site of the James A. Scully's annex. The building will be of brick construction, fireproof throughout, with a large marquee over the entrance and will be two stories in height.

N. J., Atlantic City—Erection of hotel is contemplated by Leeds & Lippincott & Co. Henry W. Leeds, President.

N. J., Irvington—Irvington Board of School Estimate granted an appropriation of $172,000 to school board for erection of twenty portable two room school buildings.

N. J., Jersey City—New building will be erected for First National Bank of Jersey City at corner of York and Hudson Sts. at a cost of about $2,000,000. Alfred C. Blossom, Archt.

N. J., Newark—Plans for the first building [illegible] school to be established in this city were approved by Charles McDermott, [illegible] of buildings of the business division [illegible] State Board of Education. School will be erected at Norfolk street and [illegible] avenue.

N. J., Newark — The Bell-Arlington Heights Association of New York will begin [illegible] at once for the erection of twelve houses. The houses will cost about $6,500 [illegible]

N. J., Newark—Walter H. Meier, of East Orange, and Martin Singer, of Newark, will erect a motion picture theater at Market and Ward streets, Newark.

N. J., Haddonfield—Work begins soon for erection of the new Tavistock Country Club House. Approximate cost $60,000.

N. Mex., Albuquerque—Board of Regents of the New Mexico University will ask legislature for $250,000 for the construction of new buildings.

N. Y., Manlius—A new three story building costing approximately $130,000 will be erected at St. John's School, Manlius. Justus M. Scrafford, of Syracuse, N. Y., Architect. Two new buildings, three stories in height, to be erected at St. John's School, Manlius.

N. Y., New York City—Until 10:30 a. m., Dec. 27, by the Department of Public Welfare, 10th floor, Municipal Bldg., Manhattan, for furnishing labor and materials for the following: Repairs and alterations, male dormitory additional story, extension to Ward L, alterations to staff house, balcony enclosure, Ward K, all located in the New York City Home District, Blackwells Island.

N. Y., Rochester—The Buy-a-Home Corporation contemplates the erection of ten houses in Cherry street near Charlotte boulevard. Each house estimated to cost $4,000.

N. C., Asheville—Citizens will vote on a bond issue of about $500,000 to provide for new buildings and additions for schools. Plans include two story fourteen room school, additions to high school in West Asheville, 14-room building in north section of the city, a 12-room school in southern portion of the city, 12-room school at Catholic Hill, for negro children, 8-room addition at the Park Avenue School, and a four room addition at the Ashland Avenue School. W. H. Lord, Architect.

N. C., Greensboro—The North Carolina College for Women will ask for an appropriation to provide heating improvement for North Carolina College, including dormitories, dining halls, classrooms, a gymnasium, an enlarged library, home for teachers, and a music building and a domestic science building. Estimated cost $3,500,000.

N. Dak., Mandan—Board of Education will consider plans soon for the erection of a high school building at an approximate cost of $100,000 and a grade school building at $25,000.

O., Cincinnati—Until noon, Jan. 10, at office of the Clerk of the Board of Education, 8th floor, Denton Bldg., 7th and Race Sts., Cincinnati, for the installation of a 36-in. cupola steel pressure blower and motor complete in the East Side High Public School, located at Erie and E. Madison Ave.

O., Cleveland—Sam Kaplan & Sons, army and navy store, plan the erection of a two-story fireproof structure with a foundation adequate to carry six additional stories, at the corner of Prospect Ave. and East 14th St. Sogg & Wertheimer, Hippodrome Bldg., Archts.

Ohio, Columbus—According to Bishop Hartley a new Catholic Home for Girls will be constructed in the near future.

Ohio, Hamilton—The Estate Stove Company will erect a shipping room building at a cost of $50,000.

Okla., Muskogee—This city plans to expend $180,000 for additional buildings and equipment and new structures for the improvement of the School for Blind Children.

Ore., Eugene—A large hotel will be erected at corner of Sixth Ave. and Willamette St. at a cost of about a million dollars, according to G. F. Davis of Eugene.

Ore., Pendleton—The people of Union High School District No. 3 comprising ten school districts around the Milton-Freewater voted to expend $150,000 to build new high schools and $50,000 for the ground and equipment. Bids will be called next February. Raymond W. Hatch, of Pendleton, Architect.

Ore., Portland—Sutton and Whitney, Architect, Lewis Bldg., will prepare plans for a ten story reinforced concrete building to be erected by Meir and Frank on the blocks bounded by Everett, Flanders, 13th and 14th street. Estimated cost of building, $1,000,000.

Pa., Elizabethtown—The state Masonic committee, authorized the erection of a boys' home. Estimated cost $50,000. M. I. Kast, of Harrisburg, Architect.

R. I., Pawtucket—A new resident building for the thread concern of the J. & P. Coats (R. I.), Inc., at Pawtucket will be erected at an estimated cost of $150,000.

Tenn., Etowah—The Louisiana and Nashville machine shop destroyed by fire at Etowah at a loss of between $150,000 and $175,000 will be rebuilt soon.

Tex., Austin—Plans are being prepared for a new building at the University of Texas. The legislature will be asked for funds, about $10,000,000, to start the work. Dr. R. E. Vinson, President of the University.

Tex., Beaumont—Voters approved bonds to provide for the erection of an auditorium and library at $250,000, and school improvements at $500,000.

Tex., College Station—President Bizzell of the Agricultural and Mechanical College has outlined plans for the improvement which will involve an expenditure of $500,000. The mechanical engineering shops recently destroyed by fire will be replaced soon. The building will cost $100,000. Machinery $50,000.

Tex., Fort Worth—Fort Worth and Denver City Railroad will spend approximately $3,000,000 for buildings and construction during 1921, according to F. E. Clarity, vice president and general manager.

Tex., Houston—The Price-Booker Co. pickle factory located at 24th and Railroad Sts., was destroyed by fire at a loss of $200,000; a new building will be constructed as soon as possible, according to G. L. Hunter, President of the company.

Utah, Provo—Bids will be readvertised for completion of the city and county building, Joseph Reece, chairman of the County Commissioners.

Utah, Salt Lake City—The State Fair Board will ask for an appropriation of $53,000 for the improvement, including the enlargement of ground extending across the Jordan River and the constructing of additional buildings.

Va., Charlottesville — The Albemarle County Commissioners adopted resolution providing for an election next spring to vote on bonds of $150,000 for the erection of a court house for said county.

Va., Richmond—Mayor Ainslie signed ordinance authorizing a $1,500,000 bond issue for school improvements. Construction program is being outlined by Albert H. Hill, Supt. of Schools.

Wash., Anacortes—Plans and specifications are being prepared by Architects Ivey and Riley, A. I. A., Boston Blk., Seattle, Wash., for the erection of a 3-story apartment house at Anacortes. Approximate cost, $40,000.

Wis., Antigo—A theater building will be erected by Harvey Hanson on 5th Ave., at an approximate cost of $100,000.

Wash., Yakima—The Shepard Fruit Products Co. will erect a factory at Yakima early next spring. The cost will be between $50,000 and $60,000. Otto A. Cass of Wenatchee interested in project.

Wash, Yakima—Improvements costing about $50,000 are to be made at once at the plant of the Trustees Lumber Company. Plans call for the installation of new boiler plant, new saws and general repair work.

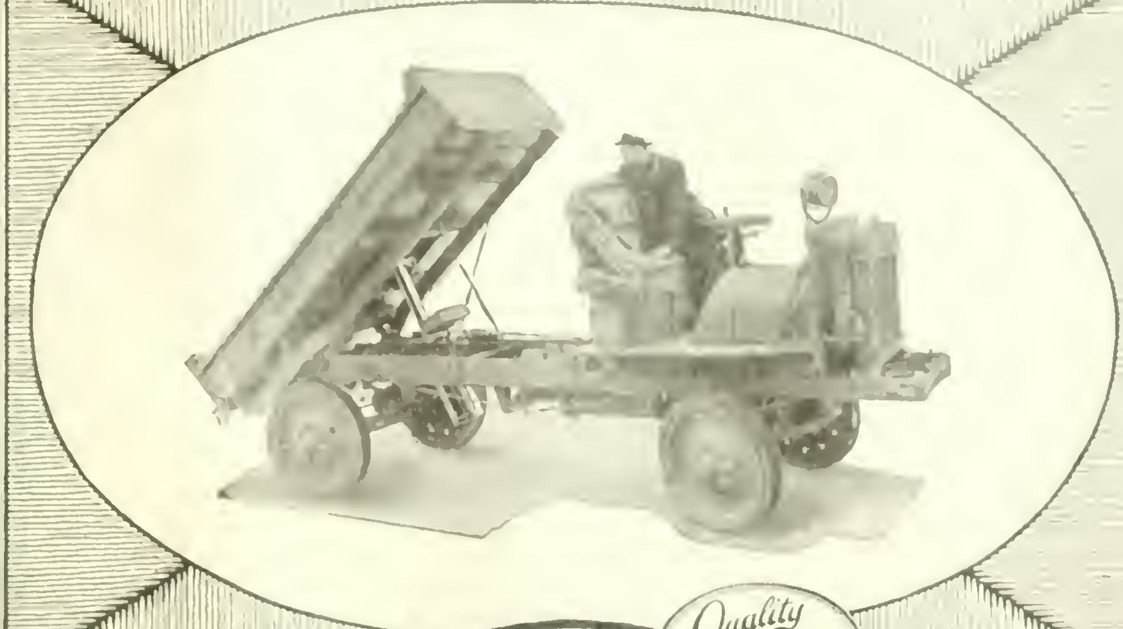
Wis., Highland—A special committee appointed by the Rev. Father Arentz, head of the St. Anthony of Padua Catholic Congregation, approved plans prepared by Monroe Architects for a $50,000 parochial school.

Wis., Milwaukee—The 1921 budget approved by the Board of Estimates includes a bond issue of $200,000 for South View Hospital additions.

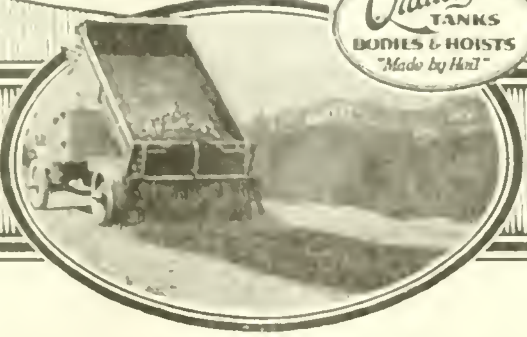
Wis., Milwaukee—The 1921 budget approved by the Board of Estimates includes a bond issue of $2,000,000 for school; $500,000 for a soldiers and sailors' memorial; $400,000 for a vocational school; $250,000 for a central police station; $10,000 for baths, 4th and 16th Wards; $100,000 for baths for 9th, 19th and 22nd Wards; $70,000 for baths for Lake Shore Park.

Wis., Minocqua—A new business block will be erected by George Lane of Chicago and William Hill of Lac du Flambeau. The building will be located on the block south of the Victor Theater.

Wis., Stevens Point—Stevens Point Hotel Company plans the erection of a five story hotel at an estimated cost of $150,000. F. L. Body, secretary of the company



Quality
TANKS
BODIES & HOISTS
"Made by Heil"



INCREASE TRUCK EFFICIENCY
With Hydro Dumping Equipment

Road Builders, Contractors, Trucking Concerns of all kinds, are finding it profitable to specify Hydro Dumping Equipment when buying trucks. The increased efficiency of any truck so equipped results in increased earning capacity.

When investigating dumping mechanisms, note the following superior features of Hydro Equipment:

(1) Unlimited lifting power of the Hydro Hoist.
(2) Convenient method of control (levers in the cab).
(3) Accessibility of hoist and truck parts.
(4) Ease of dumping on uneven ground.
(5) The use of all the loading space back of the cab. This makes it possible to use a body with lower sides.
(6) The elimination of cables, pulleys, pipes, arms, rollers and the like, making for safety and dependability.
(7) Tapered bodies allowing a clean dump or spread of gravel (note insert).
(8) Use of Heil's 100% Manual Tailgate Control and Chain Spreader Device.

Write for our catalog showing various body designs. Welded Tanks of all kinds.

THE HEIL CO.

1138-50 Montana Avenue, Milwaukee, Wisconsin

Branches: The McKenna Co., Cleveland — The Heil Co., Chicago — The Heil North-Western Sales Co., St. Paul

Wyo., Casper—The Standard Oil Co. [illegible] contemplates erecting [illegible] homes for employes in Casper.

Rivers - Harbors

D. C., Washington—Report filed with Congress by the Army Engineering Corps recommends the improvement by the Federal Government of the Calcasieu River to provide a 1[illegible] foot channel between the city of Lake Charles and the Gulf of Mexico. Construction at Lake Charles of a turning basin 1,[illegible] feet long and [illegible] feet wide also recommended.

Fla., Tampa—Board of Port Commissioners will start work soon for the construction of bulkhead and [illegible] wharf [illegible]. Benjamin Thompson, Engineer.

Fla., Jacksonville—City Council recommended a bond issue of $1,[illegible] for the municipal docks and terminals. Plans call for [illegible] a new pier, railroad tracks and equipment, including three [illegible] and two new warehouses.

N. J., Jersey City—A movement for the establishment of a large lumber terminal on the east bank of the Hackensack River, outskirts of Jersey City, has been started by the Fulton Lumber Terminal Company.

N. Y., Albany—Edward S. Walsh, State Supt. of Public Works, recommends an appropriation of $6[illegible] for completion of Syracuse barge canal terminal.

N. Y., Rensselaer—State Canal Board approved plans for the construction of a canal terminal at Rensselaer to be situated south of Hudson Bridge.

Tex., Beaumont—Citizens authorized the issue of bonds of $500,000 for wharves and docks.

Wash., Kelso—Owners of land lying between Coal Creek slough and the Columbia River below Mount Solo have planned the formation of a diking district. G. J. [illegible], Kelso, Engineer.

Wis., Milwaukee—The 1921 budget approved by the Board of Estimates provides $[illegible] for permanent harbor improvement.

Power Plants

Calif., Bakersfield—At a meeting of the San Joaquin Valley Municipalities branch of the California Municipalities League, has [illegible] to unite the cities and towns of the San Joaquin Valley in a movement to [illegible] the power sites for the development of hydroelectric energy.

Calif., Sacramento—The lighting of streets in the district bounded by Front and Fifth, I and O Sts. has been ordered by Commissioner of Public Works J. Q. [illegible].

Calif., San Francisco—The San Joaquin Light and Power Corporation applied to the Railroad Commission for authority to issue $[illegible] bonds to meet the cost of improvements, extension and betterments.

Ill., Springfield—The Springfield city council will install an ornamental lighting system in downtown district and place underground wires in the business district.

Ia., Des Moines—The 39th General Assembly will be asked to provide for the building of a new heating plant on the capitol extension grounds and to increase the appropriation authorized by the legislature for the construction of the Temple of Justice.

Minn., Duluth—The Duluth Edison Electric Company proposes to construct a power plant transmission line direct from the Thomson power plant of the Great Northern Power Company. Work to start soon.

N. J., Hopewell—This city considers the improvement of lighting system; matters taken up with the Public Service Electric Company for the installation of power candle lights at all important corners and cross streets.

Ohio, Columbus—According to Superintendent Turner this city plans the installation of new boilers and stokers at the Municipal light plant.

Pa., Pittsburgh—The Duquesne Light Co. will install modern equipment and provide lighting system for Borough of Millvale.

Tex., Hallettsville—Citizens voted in favor of bonds of $20,000 for purchasing and installing a new engine at the light plant.

Utah, Brigham City—The people of Brigham City and vicinity have agreed upon a plan to secure the water offered this section by the Utah-Idaho Sugar Company. The company has been organized and plans decided upon for the project. A pumping station will be installed at a point near Pioneer Park.

Wis., Milwaukee—The 1921 budget approved by the Board of Estimates provides for electric lighting $350,000.

Wis., Milwaukee—The 1921 budget provides for a bond issue of $50,000 for park lighting.

Miscellaneous

Pa., Williamsport—Reno L. Gage, Superintendent of Public Safety, plans to use $25,000 appropriated to the department for the purchase of motor driven apparatus.

Tex., Houston—Fire Commissioner Anderson has recommended to Council the purchase by the city of additional motorized fire fighting equipment to the fire department.

Bids Opened; Contracts Let

Roads-Streets

Ariz., Tucson—The West Coast Construction Co. of Tucson, Ariz., awarded contract for 12,115 sq. yd. of Warrenite-bitulithic pavement on 4-in. P. C. concrete foundation.

Ark., Fort Smith—Louis Rich Construction Co. of East St. Louis, Ill., awarded contract for construction of 40.38 miles of road in Fort Smith Road Improvement District at $70,[illegible].

Calif., Los Angeles—Conrad Scheere awarded contract for constructing concrete gutters, cement curb and cement sidewalks on Portola Ave. and Navarro St.

Calif., Los Angeles—S. Zarubica and F. S. [illegible] awarded contract for constructing cement pipe sanitary sewer in Harvard [illegible]. Andrew Jayich awarded contract for cement pipe sanitary sewer in Farmer St. and Emerald St., at $1,000.

Calif., Modesto—Standard Paving Co. of [illegible] awarded contract for 2,1[illegible]8 sq. yd. of Warrenite-bitulithic on 4-in. P. C. concrete foundation.

Calif., San Francisco—The Fay Improvement Co. awarded contract for the improvement of Laguna Honda boulevard from Lawton street to Woodside avenue. Grading cut per cubic yard 90 cents, making [illegible] total price per cubic yard 1[illegible]; [illegible] Type A pavement, asphaltic concrete wearing surface without [illegible], price per ton in place $[illegible]; [illegible] Type B pavement, 6-inch concrete foundation and 1½-inch asphaltic concrete wearing surface, 2[illegible] cents per square foot; constructing standard concrete [illegible] cents per lineal foot, constructing [illegible] $[illegible].

Calif., Vallejo—The United Construction Co. awarded contract for improving Fifth street from the Southern Pacific tracks to [illegible] avenue; also for the improving of [illegible] to the ferry between Aden and [illegible] streets.

Del., Dover—W. E. Allen, Baltimore, Md., low bidder for constructing 4.51 miles of state highway grading in New Castle county, at $66,121.

Ill., Lockport—R. F. Conway Co. of Chicago awarded contract for improving Hamilton, Washington and other intersecting streets in the city of Lockport at $215,902.

Ind., Fort Wayne—County Road Department, in charge of Supt. William G. Tonkel will do the resurfacing work on Twp. road in Allen County. Estimated cost about $3,000 a mile, or a total of $60,000.

Ind., Indianapolis—The Sheehan Construction Co. awarded contract for grading and graveling Chester avenue at $1,590; Linden street, $1,124, and 26th street, $3,892.

Ia., Allison—R. H. Waugh of Clarksville awarded contract for tiling 55,575 feet of 6 inch tile and 685 feet of 12-inch tile. F. E. Shugart of Nevada, Ia., awarded contract for grading approximately 13 miles in Butler County. Yegge, Morgan & Johnson of Boone awarded contract for loading, hauling and spreading the gravel at [illegible] cents for the first mile hauled and [illegible] cents per cubic yard for the next half mile.

Ia., Boone—Munson & Son of Boone awarded contract for graveling 13½ miles of primary road known as the Boone-Madrid Road at $40,271.

Ia., Hampton—J. E. Kughn & Sons, Dows, Ia., awarded contract for grading approximately 10.57 miles of primary road north and south of Hampton at 48.5 cents per cu. yd.

Ia., Sioux City—C. F. Lytle, Sioux City, awarded contract for constructing grading, draining and paving on 2.73 miles of Sioux-Onawa Road and 14 miles of the Sioux City Mobile Road at $3.67 for hard surfacing with concrete, grading and incidental $1.1[illegible] cu. yd.

Kan., Columbus—Contracts for the construction of Kansas highway, Cherokee County Federal Aid Project No. 73, Oswego Road awarded as follows: Sec. A, awarded to W. C. Jucksch, Sapulpa, Okla.; Sec. B to Koch & Kost, Joplin, Mo. Contracts for the construction of Federal Aid No. 71, Spring Valley Road, as follows: Sec. A, to Joplin and Galena Road Commissioners, Joplin, Mo.; Sec. B, to Koch & Kost, Joplin, Mo.

Mass., Chelsea—Warren Brothers Co. of Boston awarded contract for 7,779 sq. yds. of Warrenite-bitulithic resurfacing.

N. J., Elizabeth—Fillippone, Scanniello & Capozio awarded contract for laying 4-ft. bluestone sidewalks on Williams avenue at $1,212.

N. J., Tottenville—The contract for the rebuilding of Arthur Kill Road from Tottenville to Richmond awarded as follows: Contract No. 1, to Joseph Johnson & Son, $215,207; contracts No. 2 and No. 3, to William P. McDonald Construction Co. at $165,405 and $165,270, respectively; contract No. 4, to John E. Donovan, at $161,043. Total length of road to be paved with reinforced concrete 16 feet wide and 8 inches thick, nine miles.

N. Mex., Santa Fe—J. V. Stryker Construction Co., Denver, Colo., awarded contract for New Mexico Federal Aid Project No. 23, De Baca county, at $33,672.

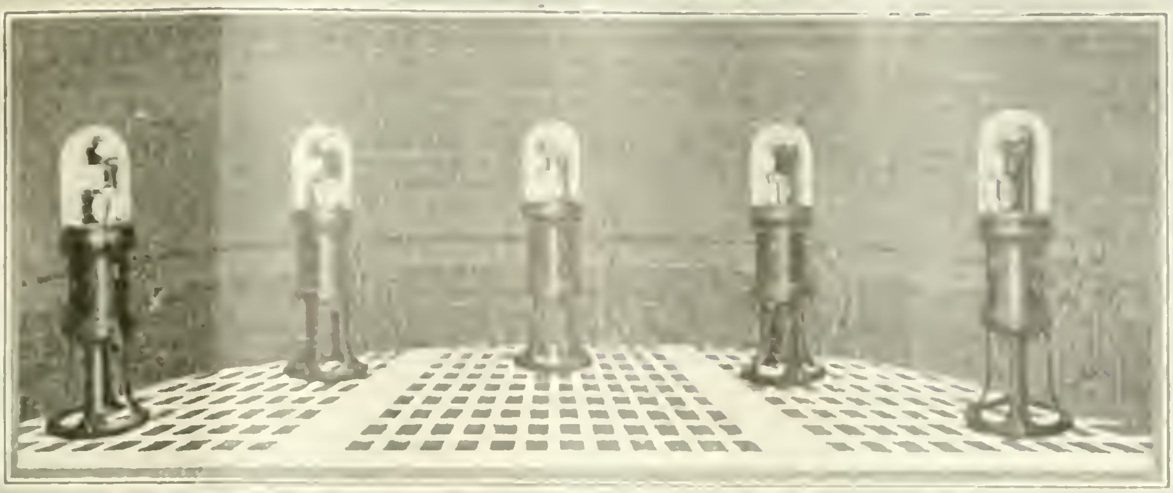
N. Mex., Santa Fe—Dan La Roe, Palestine, Tex., awarded contract for the construction of Federal Aid Project No. 28, Grant county, 13.827 miles. Work consists of cement, concrete and crushed stone surfacing, grading and drainage structures on said road, at $211,090.

N. Mex., Santa Fe—J. V. Stryker Construction Co., Denver, Colo., awarded contract for construction of Federal Aid Project No. 23, De Race county, 8.747 miles, at $37,040.

N. Y., Belvidere—The Masterson Construction Corp. awarded contract for the Hope-Blairstown road, a distance of a little over 5 miles, at $109,365.

N. Y., New York City—The Union Paving Co., of 2875 B'way awarded contract for furnishing labor and material for repaving with asphalt mastic the walks of Riverside Park, in the borough of Manhattan, at $9,010.

Tex., El Paso—The El Paso Bitulithic Co. awarded contract for 21,307 sq. yd. of



To the right is shown an Exterior View of the Memorial Tower and Meter Station.

Simplex Meter Recorders. Interior View, Showing Remarkable Installation by Simplex Valve & Meter Company for Metering Water Supplied to the Five Distribution Systems of Newark, New Jersey.

Use the Coupon opposite for a free copy of "METHOD OF METERING THE WATER SUPPLIED TO THE FIVE DISTRIBUTION SYSTEMS OF THE CITY OF NEWARK, N. J."

By GEORGE SANZENBACHER
Engineer and Superintendent
Dept. of Water, Newark

Tear off here

This pamphlet [illegible] [illegible] and unique [illegible] A similar number [illegible] distribution

Send to

Address

SIMPLEX VALVE & METER CO.
PHILADELPHIA, PA.

1½-in. Warrenite-bitulithic pavement on 5-in. concrete foundation at El Paso.

Tex., El Paso—The Lee Moor Construction Co. awarded contract for the construction of 12 miles of concrete road extending from Fabens to the eastern boundary [illegible] the county at $380,109.

Utah, Salt Lake City—More than $1,-[illegible] will be spent on road work in the national forests of the Intermountain Forest District during 1921 according to a report at the office of the Wasatch Forest.

Wash., Seattle—Jahn & Bressi, 710 New York Block, Seattle, low bidders for the sluicing of 180,000 cu. yd. of material into Elliott avenue at $1[illegible]257.

Wash., Seattle—Moore Construction Co. low bidders for paving four miles of the Cheney highway near Spokane at $49,054.

Bridges

Ill., Lawrenceville—G. H. Gocdlink of Lawrenceville awarded contract for constructing four reinforced concrete bridges to be built on the county lines between Crawford and Lawrence Counties, including 248 cu. yd. reconcrete, known as the Birds, Montgomery, Mt. Zion and Vincel bridges at $6,572.

N. H., Portsmouth—The American Bridge Co. of Boston was low bidder for construction of a superstructure of the new Piscataqua Memorial bridge at $619,000.

N. J., Elizabeth—Linde & Griffith, low bidders for constructing bridge over the Elizabeth River at South Front street, at $198,000.

Wis., Ashland—T. E. Telstech, Menominee, Wis., awarded contract for the construction of bridges as follows: Anderson Bridge on the Federal Truck Highway, $2,430, Devingor Bridge on Brunswiller Creek at $3,384; Mellen Bridge over Devils Creek at $2,826.

Drainage - Irrigation

Ill., Jacksonville—F. H. Foote of Dickerville, Mich., and W. F. Sternberg of Piper City, Ill., low bidders at 25 cents per cubic yard and 26 cents per cubic yard, respectively, for a total of approximately 124,000 cubic yards of excavation for Mud Creek Drainage District, of Morgan and Cass counties.

Ia., Wapello—Fred E. Smith, Clarion, Iowa, awarded contract for the construction of drainage district No. 22, comprising five miles of ditches at 71,000 cubic yards of earth excavation at 37½ cents.

Nebr., Oshkosh—Frank McCarter of Bayard, Nebr., is the principal contractor for the reconstruction of canal for the North River Irrigation District. Project will involve an expenditure of $120,000.

Utah, Salt Lake City—Bonneville Irrigation District awarded contract to the Shattock Construction Company of San Francisco for building a pumping plant and distributing system through the said district. Work to involve an expenditure of $600,000.

Sewerage - Sanitation

Calif., Los Angeles—John Sutalo awarded contract for construction of cement pipe sanitary sewer to be constructed in Ravenna Ave. and in J St., at $2,819.

Calif., Los Angeles—John Balch awarded contract for constructing cement pipe sanitary sewer in Ocean Ave., in Seaside Ave. and in Harris Place, in alley southeasterly from Ocean Ave., in Bayonne Place, in Riverside Place and in first in first alley southeasterly from Ocean Ave.; in Ontario Walk and in Division Place, Bayonne Place, Caserta Place, in Herne Place, in Riverside Place, in Scranton Walk, and in Ontario Walk and Geneva Place. Total cost for sewer complete $54,711.

Calif., Los Angeles—Adam Dalmatin and Mike Guho awarded contract for constructing vitrified clay pipe sanitary sewer on [illegible] St. and Galena St., at $4,500.

Mo., Springfield—Ralph Langston of [illegible] awarded contract for the construction of the following 25,230 ft. 8-inch standard vit. sewer pipe, including 87 manholes; 660 yards, 8 flush tanks and lamp holes, at $43,596. Crushed rock at 70 cents per foot.

N. Y., New York City—Kennedy & Smith, 94 Main St., Flushing, awarded contract for construction of sewers to connect with Queensboro Hospital at $24,[illegible].

N. Y., Ossining—Carroll Contracting Co., [illegible] Park avenue, N. Y., will probably be awarded contract for sanitary work, sewerage and water supply systems, Sing Sing Prison, Ossining, N. Y.

Pa., Erie—Willis Bancroft, Jr., low bidder for a nine inch sanitary sewer on 21st street at $1,522.

Waterworks

Ill., Moline—The National Engineering Co. of Davenport awarded contract for the construction of storm drain extending from First to 13th street and from the north limits of the city to the foot of the hill district, cost $236,000.

N. C., Kinston—R. L. Blalock, Kinston, awarded contract for power plant building, Auxiliary Pumping Station Bldg., Machinery and Chimney Foundations at $78,000.

Tex., Port Arthur—Board of Supervisors of the Fresh Water District awarded contract to Nagle, Witt & Rollin for work at Port Arthur at a 5 per cent basis. A bond issue of $2,000,000 was recently voted for this project.

Buildings

Calif., Los Angeles—The J. C. Thurman Co., El Monte, Calif., low bidder for furnishing labor and material for the construction of a four-room and sanitarium additions and alterations to the present school building on the north side of Durfee road, corner of Lexington avenue, at $64,977.

D. C., Washington—Skinker & Garret, 1416 G. St., N. W., awarded contract for tho construction of an 8-room addition to the Takoma School No. 118, located on the Piney Branch Road and Dahlia St., Takoma Park, D. C., at $152,972.

Md., Baltimore—The Standard Construction Co. awarded contract for school No. 76, Latrobe Park, Baltimore, Md, at $144,500.

Md., Baltimore—The Standard Construction Co., Philadelphia, Pa., awarded contract for the construction of school buildings at Latrobe Park, Baltimore, for $465,000.

Mass., Boston—C. S. Cunningham and Son Construction Company awarded contract for constructing municipal buildings for Hyde Park, $253,556.

Okla., Muskogee—The Manhattan Construction Company of Muskogee awarded contract for the construction of a million dollar sanitorium to be erected three miles from the town of Talihima in the Kiamichi mountains.

Okla., Oklahoma City—S. A. Layton, Archt., presented plans to the city planning commission for the proposed union station to be erected at an estimated cost of $800,000.

Ore., Portland—The Mangus Taylor Company, contractors, Panama Building, will rebuild Lyric Theater Building, which is to be used as a ticket office for the Southern Pacific Electric lines. New building will cost $60,000. Contracts for the following have not been let: Marble, flooring, mill work and hardware.

Pa., Barnesboro—James O. Lunt & Son awarded contract for the erection of coal tipple at new mine for the Moss Creek Coal Co.

Pa., Erie—Prahl Construction Company of Harrisburg will be awarded contract for construction of the second unit of the battalion armory at $32,932.

Pa., Erie—The Prahl Construction Company, low bidders for construction work on the East High School, at $198,039, for the main building, and $30,719 for the shop wing work.

S. Dak., Mitchell—Sugarman Construction Company, Des Moines, awarded contract for construction of $200,000 corn palace auditorium.

Utah, Salt Lake City—Villadsen Bros., Dooly Bldg., Salt Lake City, awarded contract for furnishing labor and material for the Roosevelt Junior High School located on Lincoln avenue between 8th and 9th South streets at $141,709.

Ind., Fort Wayne—J. M. E. Riedel of Fort Wayne awarded contract to construct a hospital in Ambur, India. Dr. Theo. Doederline of Chicago will be in charge of hospital.

Wash., Seattle—Eckart Plumbing and Heating Company of 1614 Third avenue awarded contract by the Sound Construction and Engineering Company, Lowman Building, for the plumbing, heating and ventilating of new 10 floor Telephone Bldg, 3rd avenue and Seneca street, at $180,000.

Rivers - Harbors

Ky., Louisville—H. P. Gazzam Machine Co., Pittsburgh, Pa., was low bidder for the following : Lot A, Gate Operating Machinery, at $6,500; Lot B, Valve Operating Machinery, at $10,750. Lock No. 48, Ohio River.

Pa., Philadelphia—The American Dredging Company, Philadelphia, low bidder, for dredging in Delaware River at 29 cents per cubic yard, scow measurement. Estimated quantity of material to be removed about 600,000 cubic yards.

Va., Petersburg—George, Hankins and George, Richmond, Va., and the W. P. Thurston Co., Richmond, Va., were low bidders for constructing reinforced concrete conduit in Appomattox River, Va., near Petersburg, Va. Both companies bid $23,000.

Wash., Seattle—The lowest bid received by the Seattle PortCommission for furnishing sand and gravel roofing for the Pier B, west Transit shed, was the Occidental Sheet Metal, at $8.98 per square. Shed requires 600 squares of 100 square feet each.

Power Plants

N. C., Wilmington—The Electric Maintenance Company of Wilmington awarded contract for the installation of electric driven machinery at the Swift Fertilizer Plant, at $10,000.

Wash., Seattle—The Ne Page-McKenny Co., Armour Bldg., awarded contract for electrical work for the Pacific Telephone Co.'s new $1,000,000 structure on Third avenue and Seneca street, at $25,000.

Miscellaneous

Ind., Indianapolis—The Automatic Voting Machine Co. was only bidder for fifty additional voting machines in Marion County at $65,000.

Mich., Detroit—The Railway Track Work Co. awarded contract for furnishing Street Railway Commission with one Universal rotary track grinder at $1,425 and one reciprocating track grinder at $2,625. The International Steel Tie Co. awarded contract for furnishing the Street Railway Commission with 8,800 steel twin ties at $8.45 each. The Cadillac Tool Co. awarded contract for furnishing Street Railway Commission with one No. 5 type Watson Stillman portable hydraulic rail bending machine at $925. The Detroit Copper & Brass Rolling Mills awarded contract for furnishing 30 miles of trolley wire on the basis of $14.62½ per cwt. The Eggers-Pole & Supply Co. for furnishing cedar poles as follows: 200 Class B, 35 ft. at $20.25 each; 100 Class N, 30 ft., $18.10 each; 50 Class B, 40 ft. at $22.35 each; 50 Class B 45 ft. treated cedar poles at $27.80.

N. Y., Central Islip—The Troy Laundry Machinery Co. of New York City, awarded laundry equipment Brooklyn State Hospital, at $20,645.

O., Columbus—The Elliott Co. of Cleveland was awarded contract for furnishing and delivering one double strainer for the municipal light plant at $2,118.

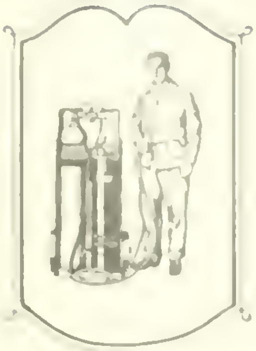
Tex., Beaumont—Citizens authorized bonds of $75,000 to fire department and $25,000 to police department for equipment and improvements.

Texas, Houston—City Electrician Clarence R. George asks for an additional appropriation of $25,000 for the purchase of many additional fire alarm boxes.

EVEREADY

WELDING AND CUTTING OUTFITS

FORMERLY *Prest-O-Lite* APPARATUS



Built for hard and continuous service by the world's largest makers

GARAGEMEN, machinists, foundrymen, plumbers and steamfitters—those whose jobs call for the greatest variety of work and working conditions—have found the strength, lightness, simplicity and economy of Eveready a great advantage.

Built by Oxweld to conform to their high standard of workmanship, Eveready Welding and Cutting Apparatus is especially designed to supply portable, easily handled and well-balanced tools of unusual strength and great simplicity of construction—apparatus to stand up under the severest trials. Moderately priced and of low operating expense—no equipment made is better for its purpose.

Eveready Apparatus and Supplies are on sale everywhere. Fill in and mail the coupon for new catalog and name and address of your local distributor.

OXWELD ACETYLENE COMPANY
(Eveready Apparatus Dept.)
3644 JASPER PLACE, CHICAGO, ILL.

WORLD'S LARGEST MAKERS OF OXY-ACETYLENE WELDING AND CUTTING OUTFITS

OXWELD ACETYLENE COMPANY
(Eveready Apparatus Dept.)
3644 Jasper Place, Chicago, Illinois

Please mail me Free of Charge your New Eveready Catalog and address of your distributor in my locality.

Name

P. O. Address

Fill in the coupon TODAY

OB-510

Save Time in Reading and in Searching for Information

ENGINEERING AND CONTRACTING is published as four monthly magazines corresponding to each of the four divisions of the civil engineering and contracting field—(1) highways, (2) hydraulics, (3) railways and excavation, (4) structures. These four monthlies are so co-ordinated in weekly sequence as to produce a weekly journal whose articles cover the entire field of civil engineering. The contract news of the entire civil engineering field appears in every issue.

In the year there are four months having five Wednesdays. On these "5th Wednesdays" we publish our four Foreign Engineering Review Quarterly issues, devoted to improvements made in foreign countries in the civil engineering field.

Roads and Streets Monthly

Published the 1st Wednesday of each month. This monthly issue contains articles written for those who design, build and maintain country roads and city or village streets. Highway engineers and contractors, city and county engineers, road and street superintendents require—and this issue of ENGINEERING AND CONTRACTING furnishes—a highly specialized lot of articles containing new and usable information on:

(a) Roads (c) Street Cleaning
(b) Streets (d) Municipal Miscellanies

Waterworks and Hydraulic Monthly

This issue, published the second Wednesday of each month, is of immediate use to hydraulic, sanitary and irrigation engineers, superintendents and contractors. Its articles relate solely to what may be broadly called hydraulic or water problems—waterworks, sewer and sanitation drainage and irrigation, water power. This Waterworks and Hydraulic Monthly issue is the only American periodical, other than society proceedings, whose articles relate exclusively to the field of hydraulics. It stands, therefore, in a class by itself. It covers:

(a) Waterworks (c) Irrigation and Drainage
(b) Sewers and Sanitation (d) Power
(e) Management and Office System

These Two Issues Completely Cover the Municipal Engineering Field

Railways and Excavation Monthly

This issue, published the third Wednesday of each month, affords engineers and contractors engaged in excavation work the only magazine specializing on this field. While excavation occurs in practically every class of civil engineering work the articles which are to be found in this issue deal with such heavy excavation as is encountered in railway work, construction of canals, harbors, river improvement, etc. This issue also contains articles on railway construction, river and harbor improvements and all other classes of government work. It covers:

(a) Excavation and Dredging **(c) Harbors and Docks**
(b) Rivers and Canals **(d) Railway Construction**
(e) Management and Office System

Buildings and Structural Monthly

Published the fourth Wednesday of each month. Probably more civil engineers specialize in structural work—buildings, bridges, etc.—than in any other branch of civil engineering.

Our Building and Structural Monthly issue is the only exclusively structural engineering periodical not published by a manufacturing firm. Its specialized appeal—through every one of its articles—is to the designer and builder of industrial and commercial buildings, all buildings involving engineering design, bridges and other structures. It covers:

(a) Buildings **(c) Ship Construction**
(b) Bridges **(d) Miscellaneous Structures**
(e) Properties of Materials

FILL IN BLANK BELOW AND MAIL TODAY

We Will Bill You Later

ENGINEERING AND CONTRACTING

608 South Dearborn Street, Chicago

____________________1920

Find enclosed $4.00 for which please enter my subscription to "E. & C." for all weekly issues, (52 in all) for one year.

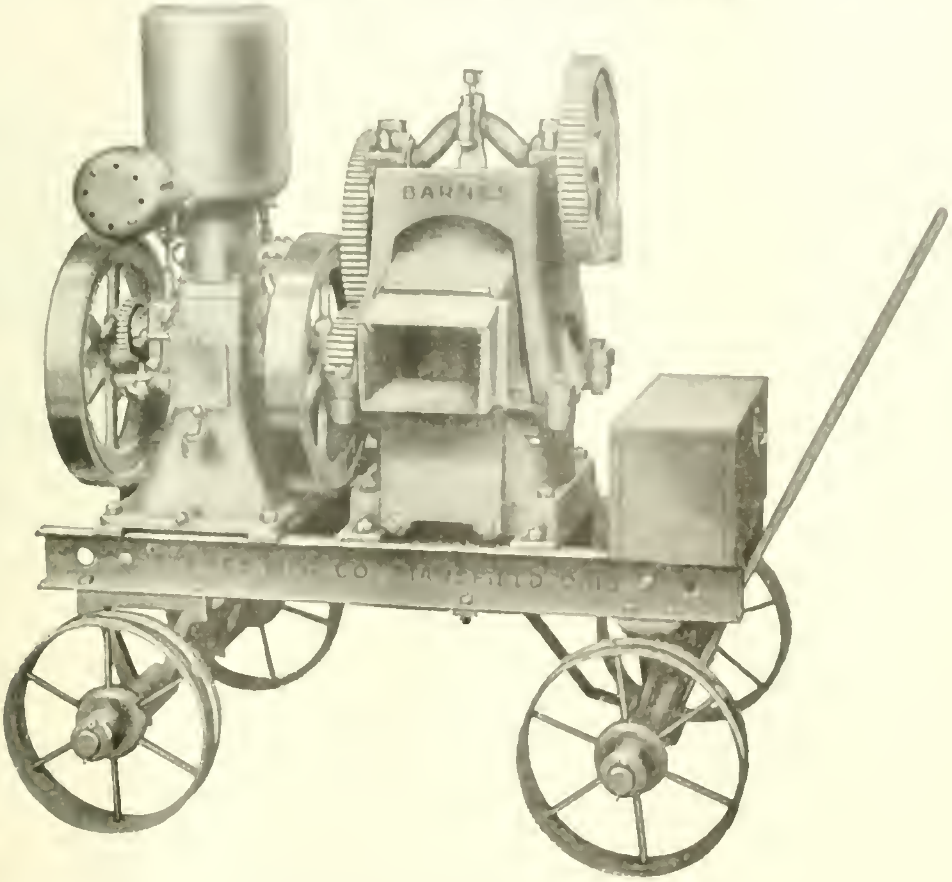
____
Please write plainly the name of individual, department, or Company.

____
Street Address, City and State.

THE BARNES

CONVERTIBLE DIAPHRAGM PUMP

TWO PUMPS IN ONE



Capacity 10,000 to 12,000 gallons per hour

Exclusive Features

Convertible—This new pump can be converted from the open spout "Anti Splash" type to the closed spout "Odofor" type by replacing only seven parts.

Suction Valve—Equipped with new type suction valve which can be removed without disturbing the suction hose.

Replacing Diaphragm—Nothing to it, because the spout, which clamps the diaphragm in place, is made separate from the Overhead Jack.

Permanent Alignment—The Overhead Jack is supported by the metal base and does not rest on the compressible diaphragm. It cannot be bolted down out of proper alignment.

WE CLAIM—That this new pump is the most practical, portable, power diaphragm pump ever developed.

Our Bulletin No. EC8 will convince you of the truth
of the above statement — Let us send it to you.

THE BARNES MANUFACTURING CO.
MANSFIELD, OHIO

Chicago Office
1105 Monadnock Bldg.

Western Office
239 E. 12th Street
Oakland, Cal.

Simple Scientific Planfiling

with the

ECONOMY U-PLANFILE

There are many good reasons why you should use our U-Planfile—why it is superior to any other system of planfiling.

The capacity of a Planfile is much greater than that of a section of drawers of the same size. Drawings are kept perfectly flat and smooth—there is no jamming or crushing. It is absolutely dustproof.

Then there is the advantage of a better classification of drawings by the use of folders—and your

Drawings Are Easily and Quickly Located

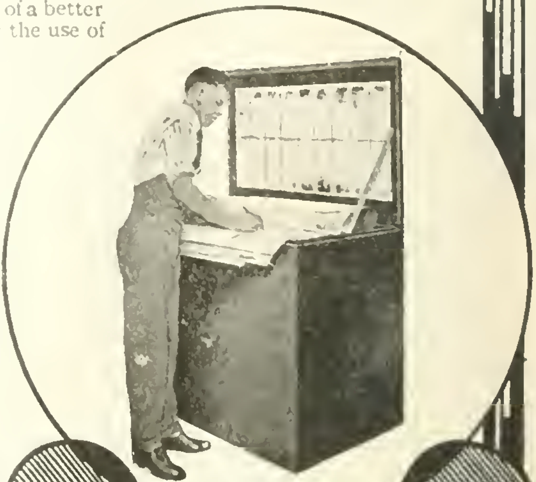
The owner of a U-PLANFILE has more filing space at his disposal than is given by any other case on the market.

The U-PLANFILE costs 65 to 95 per cent less than drawer subdividing, and there is absolute protection against water in case of fire.

We solicit your correspondence.
Let us know about your needs.

REGISTERED
ECONOMY
U.S. PAT. OFFICE

Economy Drawing Table & Mfg. Co.
Adrian, Mich.



REGISTERED
ECONOMY
U.S. PAT. OFFICE

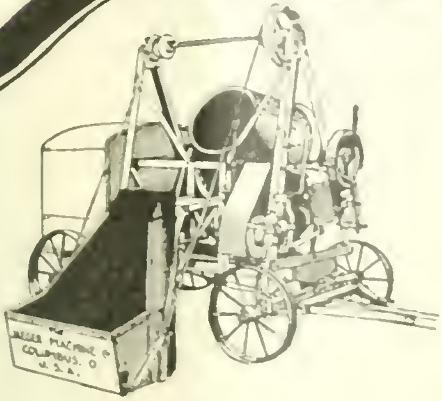
For You, Personally—

THERE is a real reason—a purpose—a message—in every advertisement that appears in Engineering and Contracting.

Each one marks its own particular phase of progress—of improvement—of something new under the sun or of something time-tested and proven.

If you read these advertisements intelligently you will find them both interesting and profitable.

JAEGER MIXERS



PREFERRED BY THE MAJORITY

There is going to be so much construction work the coming year that the amount of money the contractor can make will depend almost entirely upon how well he equips himself to secure speedy construction without sacrifice in quality.

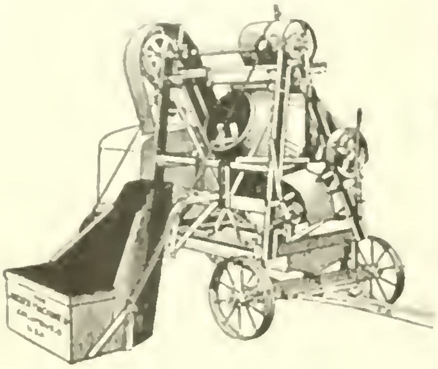
With three sizes of batch capacities—with fourteen different outfits. No matter what kind of concrete work you will have, there is a JAEGER MIXER for you. Each JAEGER MIXER is famous for being efficient, economical, strong, durable, and low in first cost.

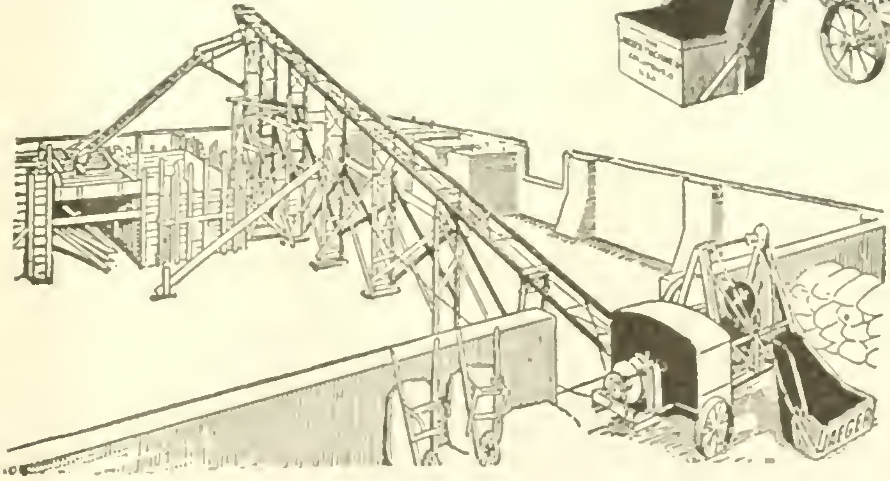
JAEGER PLACING EQUIPMENT

Puts the concrete where you want it in the shortest time. Saves 50% to 75% on building construction. Eliminates the wheelbarrow gang. No spilling of concrete, quickly erected and knocked down.

Write JAEGER Today

Get the JAEGER booklet describing the placing equipment and mixers for every need—you'll find just the machine you've been looking for. Write that letter now.





THE JAEGER MACHINE COMPANY

222 Dublin Street Columbus, Ohio

"A MIX A MINUTE"

Why the Reputation of Newport Culverts Endures

Because Newport Culverts of "Genuine Open Hearth Iron" always check up on analysis or spelter coat

As an instance of this a recent check of the Georgia School of Technology for the State Highway Department of Georgia on spelter coating showed as follows:

Laboratory No. 1487—
Material: 30 Inch Galv. Iron Culvert Pipe, Marked Ga. 120, Carroll Co
Amount of Spelter, 2.37 Ozs. per Square Foot.

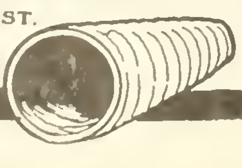
Laboratory No. 1488—
Material: 24 Inch Galv. Iron Culvert Pipe, Marked Ga. 120, Carroll Co.
Amount of Spelter, 2.20 Ozs. per Square Foot.

Our guarantee of not less than two ounces of spelter to the square foot of exposed surface is lived up to on every foot of culvert pipe we manufacture.

The above example is typical of various tests made for State Highway Departments all over the country. We are not satisfied with just coming up to the requirements, but always aim to make Newport Culverts just a little better than the specifications call for.

Send us your address and let us tell you more about them.

NEWPORT CULVERT CO.
533 W. 10th ST.
NEWPORT KENTUCKY



INSTALL A

SYMONS

DISC CRUSHER

Now to Supply Your 1921 Needs

The Symons Disc Crusher is ready to help you meet unusual conditions. Its installation in your plant means increased output—and increased output means a greater share of the new business in nineteen twenty-one.

Symons Disc Crushers give the most remarkable crushing economy and uniformity of product—operating on all sorts of material, from soft carbonates to the tough cherty ore.

Symons Crushers are economical in power consumption—excel in low repair cost and assure you of a uniform product at the lowest production cost.

Our engineers are at your service in the design of your plant and are in a position to go into the smallest detail of the arrangement of your reduction equipment.

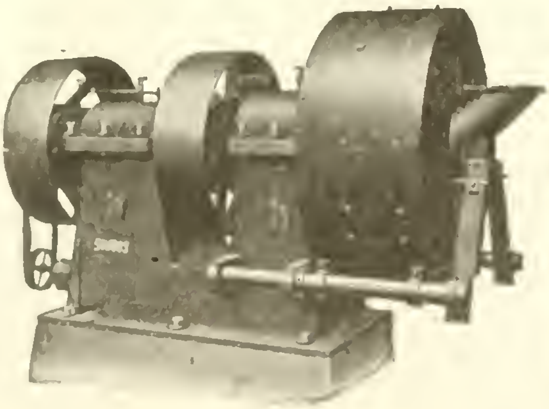
Gyratory and Jaw Crushers for Initial Breakers, Symons Horizontal Disc Crushers as Intermediate Breakers, Symons Vertical Disc Crushers as Intermediate or Finishing Crushers, Ball Mills and Tube Mills for Finish Grinding, Crushing Rolls as Intermediate Crushers, Pulsating and Revolving Screens.

All sizes in stock for immediate shipment.

Write for full technical description and other interesting data

CHALMERS & WILLIAMS

1440 Arnold St., Chicago Heights, Ill.



Cement-Gun Shooting Walls and Floor Of Flume 1¼ Miles Long

CEMENT-GUN

TRADE MARK

For Building Construction, Protecting Structural Steel, Levee Work, Lining Shafts, Masonry Repairs, Lining Irrigation Canals and other uses

TRY "CEMENT-GUN" ECONOMY AND BE CONVINCED

Gunite is a sand-cement mortar applied by the "Cement-Gun" process. It has solved a great number of unusual structural and waterproofing problems. The variety of work successfully accomplished by this process is indicated in the list mentioned above.

Our Literature shows many unique "Cement-Gun" jobs. Send *Today* for your copy.

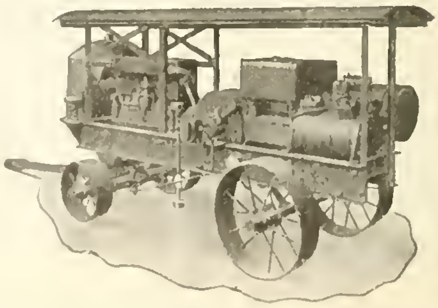
CEMENT-GUN COMPANY, INC.
Cornwells, Bucks County, Pa.
(Suburb of Philadelphia)

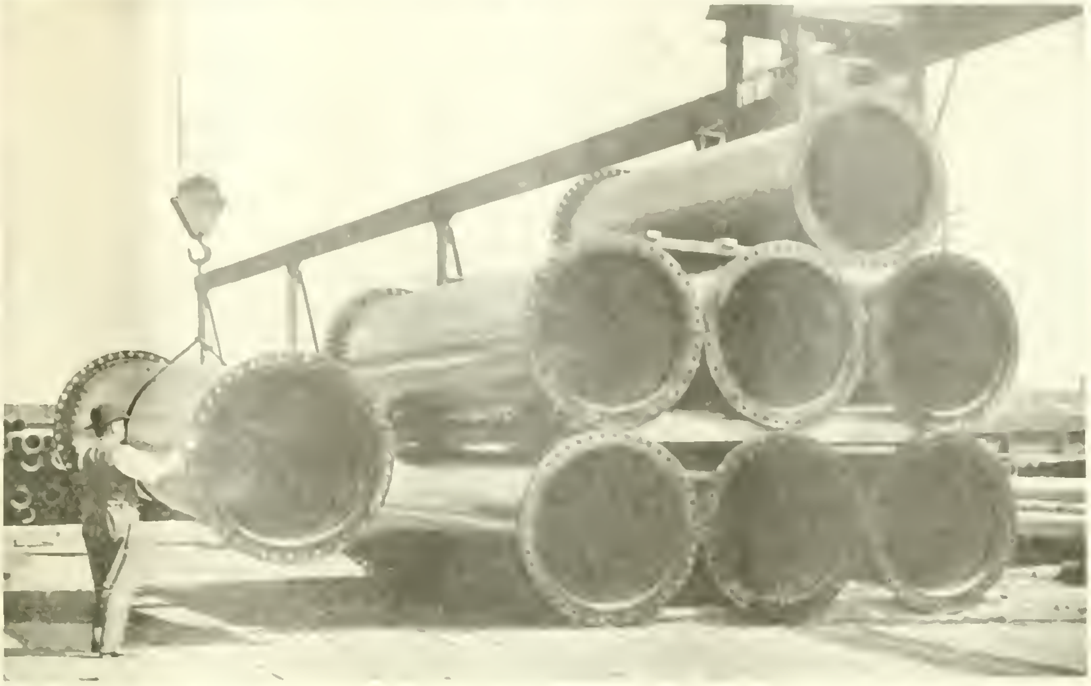
30 Church St., New York City
904 Chamber of Commerce Bldg., Chicago
211 Fulton Bldg., Pittsburgh
Citizens National Bank Bldg., Los Angeles
812 Va. Light & Power Bldg., Richmond
204 R. A. Long Bldg., Kansas City
615 Mohawk Block, Spokane

Eastern Canada—
General Supply Co., 360 Sparks St.
Ottawa, and
85 Water St., Winnipeg, Man.

Agencies in all principal foreign Countries.

Dewey combined air dryer and water heaters deliver DRY AIR to your "gun" or air tools.





LAP WELDED STEEL PIPE

12 to 72 inches

SPIRAL RIVETED PRESSURE PIPE

3 to 42 inches

No Matter Where You Are Located, You Can Be Sure of Prompt Attention to Your Needs and Suggestions that Are Very Likely to Prove Helpful.

While your particular problem may not be difficult, we welcome a chance to co-operate with you in the solution. We gladly furnish specific and complete information on any and all of the products, or in any reasonable way help you in the selection of the pipe your installation requires.

Our Lap Welded Steel Pipe made up in thickness from ¼ to 1¼ inches is especially suited for Intake Mains, High Pressure Hydro Electric Pipe, Dredging Work, Vacuum Pipes, etc.

Taylor Spiral Riveted Pipe is extensively used for long water supply lines and for Exhaust Steam around Industrial Plants.

The helical seam makes it 30 to 50 per cent stronger than other pipe of same thickness. Especially adaptable for high pressure work, as it will stand greatest pressure for its weight.

Prompt shipment from stock or special orders executed on short notice

Send for catalog

American Spiral Pipe Works

Chicago Illinois

New York City Office: 50 Church Street

TIFFIN

Reliable Equipment

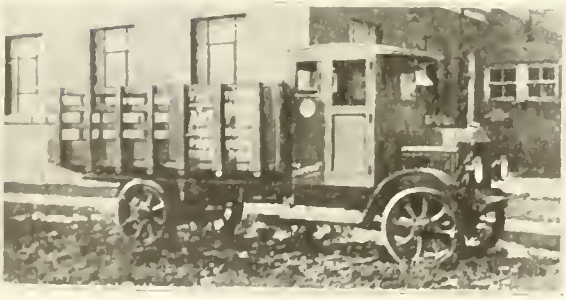
Tiffin Dumping Wagons and Trucks, also Tiffin Street Flushers and Sprinklers, have long been known for their stability and deep seated quality.

This company is an **old** concern,—a concern that has utilized each year, since founded, for steady progress and advancement.

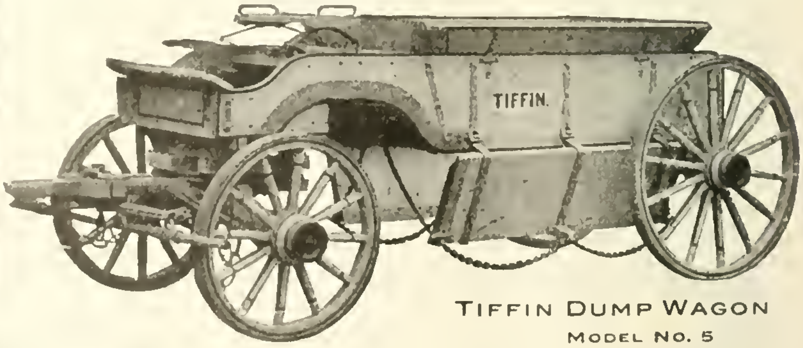
TIFFIN SPRINKLER STEEL TANK, VERTICAL SPRAYER

To buy equipment without investigating the merit of Tiffin Vehicles would look, in the light of Tiffin records, like a short-sighted policy.

We do not, however, rest content on our past achievements but are prepared to bid aggressively on your requirements. We can and will, if given the opportunity, show you sound business reasons for giving us the order. Literature on request.



TIFFIN ART METAL TRUCK



TIFFIN DUMP WAGON
MODEL NO. 5

The TIFFIN WAGON CO., *Tiffin, Ohio*

You Make No Mistake
In Selecting
ROBINSON
Segment Sewer Blocks
for
PERMANENT
SEWER CONSTRUCTION

Robinson Segment Block Sewers are easy to build and can be built only one way—the right way.

The Only Segment Block That Gives Absolute Water-Tight Construction

From both the standpoints of design and service you will be firm in the belief that it is the best sewer block manufactured.

"Distinctive" Features are
Easy to Handle
Easy to Lay
Watertightness
Practical Sub-Drain

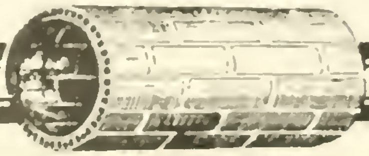
—also **Sewer Pipe**
Fire Brick and Clay
Wall Coping
Flue Liners
Stove Pipe

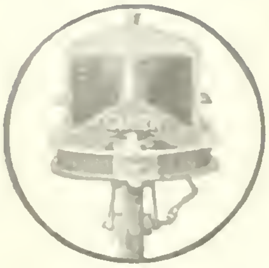
We are the **largest** and **oldest** company in the clay working industry—but our ten plants are modern! Do not hesitate to consult us about your sewer problems. Send for catalog and full particulars.

The **Robinson**
Clay Product Co. Akron, Ohio

Branches

NEW YORK CITY, 10th Floor, Flatiron Bldg.
CHICAGO, ILL., 1306 Chamber of Commerce Bldg.
BOSTON, MASS., 73 Tremont St.
BUFFALO, N. Y., 1154 Seneca St.
SYRACUSE, N. Y., 401 Fulton St.
TORONTO, ONT., CANADA, 608 Temple Bldg.





CLARK TRUCTRACTOR

The Gasoline Industrial Truck

Solves the Haulage Problem for Every Contractor

Partial List of Contractors Using Clark Tructractors:

Hastings Pavement Co.	*New York City*
Raymond A. Mercier	*Detroit*
City of Minneapolis	*Minneapolis*
W. J. Newman	*Chicago*
Schmidt Construction Co.	*Chicago*
Otis Cement Construction Co.	*Detroit*
R. J. Powelson Co.	*Detroit*
W. B. Brady Construction Co.	*Detroit*
Jacobus & Winding	*Milwaukee*
Badger Construction Co.	*Milwaukee*

The Clark Tructractor is a speedy, economical machine for distributing dry or wet material. It replaces men and wheelbarrows on road and foundation work and effects a vital saving in cost.

The machine will work from mixer to forms or from loader to mixing platform, saving time and money on each operation. The Tructractor runs 12 miles per hour, carries a yard of dry or $\frac{3}{4}$-yard of wet mix, and climbs a 20% grade under load. The Tructractor has enabled many contractors to take the bonus on penalty contracts.

Every contractor should investigate the Tructractor — a letter will bring Contractors' Bulletin and full information.

CLARK TRUCTRACTOR CO.
1130 Days Avenue
BUCHANAN, MICHIGAN

Move It Mechanically

TITAN

2-yd., 2½-ton (Short Wheel-Base) Sub-Grade Truck

Fills the gap between Stock Pile and the Paver

Paving Contractors

This special TITAN will solve your sub-grade hauling — requires 50% less equipment—50% less operators than 1-ton trucks—costs 60% less per yard material delivered.

Has speed 25 miles on high—5 miles on reverse—40 H. P. motor—dumping angle 55% for wet mix—2 or 3 compartment body.

Full details, price, cost operation, etc., on request.

TITAN TRUCK CO.

MILWAUKEE · · · WISCONSIN

PITTSBURGH METER COMPANY

QUALIFIED BY MANY YEARS' EXPERIENCE IN METER BUILDING.—

METERS FOR MEASURING
WATER, OIL, AIR, GAS, GASOLINE
AND ALL OTHER FLUIDS.

"MONEY SAVED IS MONEY EARNED"

If you still supply water on the flat rate basis, you can, without lowering your revenue, increase the distance between income and expenditures, by metering your supply.

Let us tell you how others have successfully overcome public prejudice against the meter system.

Pittsburgh Meter Company

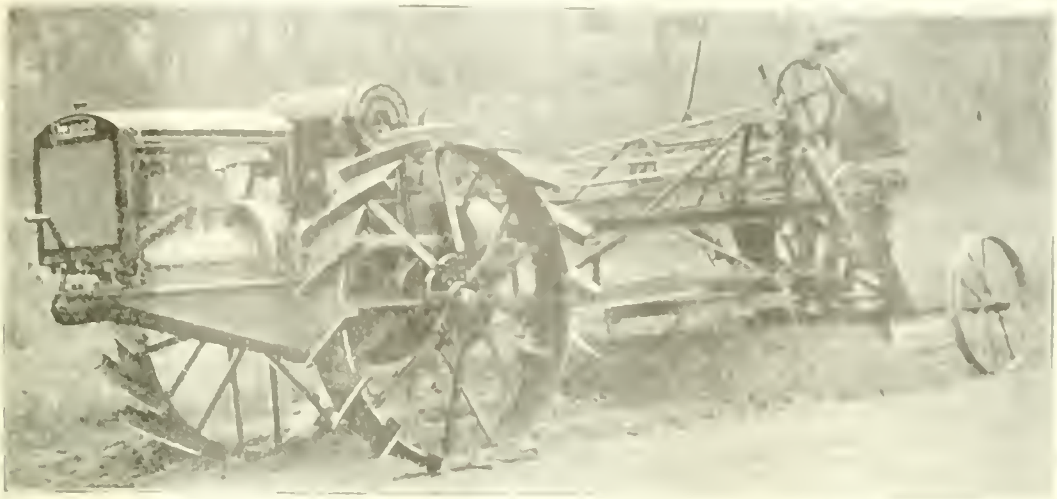
General Office and Works: East Pittsburgh, Pa.

SALES OFFICES:

New York—149 Broadway
Chicago—5 S. Wabash Ave.
Kansas City—Mutual Bldg.

Columbia, S. C.—1433 Main St.
Los Angeles—Union Oil Bldg.
Seattle—802 Madison Street

The Shawnee POWER-PATROL A Power Grader for Road Builders



In a demonstration at Champaign, Illinois, a Shawnee Power Patrol built a 30 foot width of boulevard street at an agreed cost of $[illegible] 76 per mile

A One-Man Implement For Road-Building Contractors

Any road-builder realizes that a one-man power grader will bring in big returns as a part of his road building equipment.

One man operates the Shawnee alone. This machine has a high speed gear for light work; a low speed for heavy work; and a speed in the reverse. The entire outfit turns easily on a 16 foot width of road.

The Shawnee is not a farm tractor put on the road. It is a specially designed power-grader, built to do road-work.

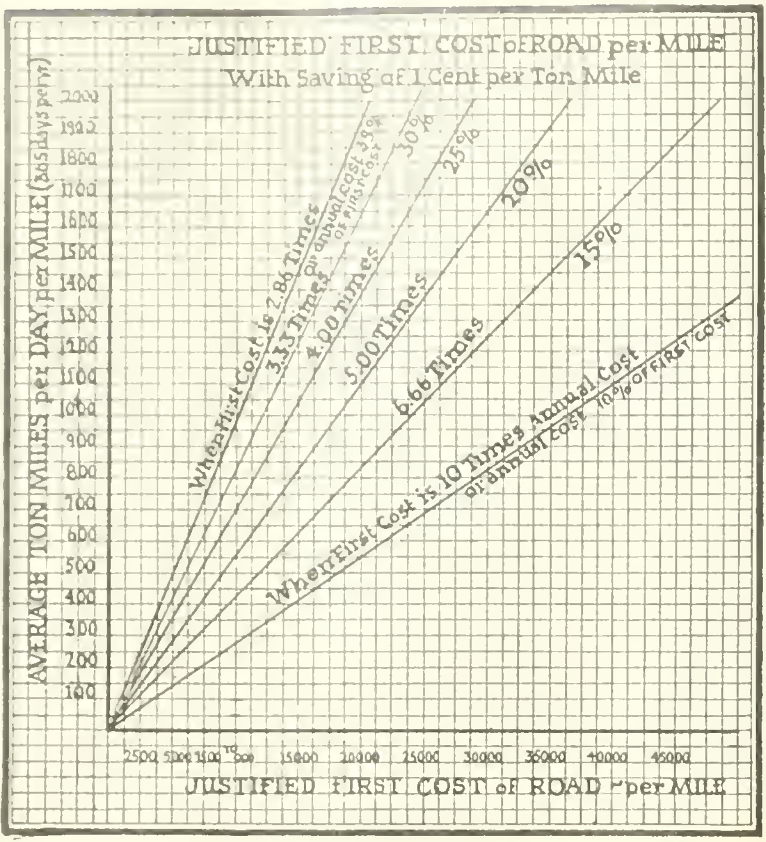
Fits In With Equipment You Now Have

The Shawnee fits in with the road-building equipment you now have. On direct drive it will do all of your leveling and finishing off, either on new roads or in preparing city streets for pavement. On low gear it will prove the cheapest tool for building short stretches of new earth surface roads. With its two-speed transmission it operates with greatest economy whether doing light or heavy work.

Write Us for Full Information

Shaw-Enochs Tractor Co.

2436 University Ave., S. E.
Minneapolis, Minnesota



"If the saving in operation of the vehicles aggregates as much per annum as the annual allowance for interest, maintenance and depreciation, the outlay may be regarded as economically justified."

The curves are calculated upon a saving of 1c per ton mile for each of 6 typical roads which range in annual cost from a minimum of 10% to a maximum of 35%.

What Can Your Community Afford For Road Construction?

First, make a traffic count to determine present traffic load on the road to be improved. Next, carefully estimate the traffic increase which the improved road will attract, and add to the traffic load as found. By referring to the chart which is illustrated above you can arrive at the justifiable first cost of any proposed highway.

For example, with a ton mile aggregate of 1000, the justified first cost as shown by the chart is $24,500 at an annual estimated cost of 15%, with a saving of 1c per ton mile.

Our latest engineering publication, Asphalt Association Brochure on "Highway Economics", discusses the justifiable first cost of roads in detail. It will be forwarded to public officials, engineers and contractors free on request.

THE ASPHALT ASSOCIATION
25 West 43d St., New York City
Chicago, Toronto,

ASPHALT

Proved through the Ages

Write for Asphalt Association Brochure on this subject

Concrete Roads and Safety First

You're safe on concrete—whether the surface is wet or dry, whether you are running in "high" or "low," uphill or down, on the straightaway or around a curve—the even, gritty surface of the concrete pavement makes you sure of car control.

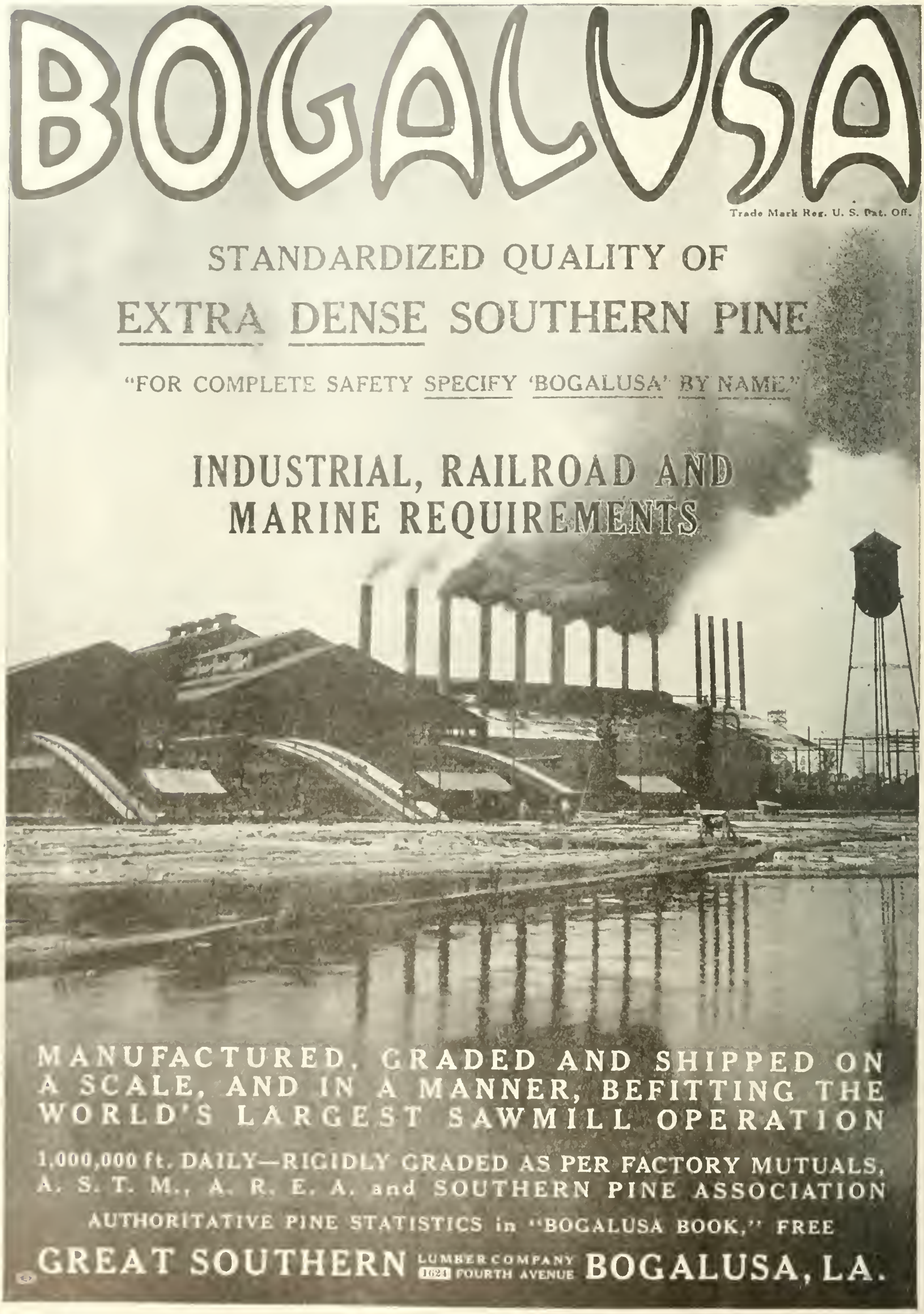
You can depend on the Concrete Road—no other type gives so sure a grip for your tires, with so little tractive resistance. That's just *one* reason why you see Concrete Roads everywhere. It's not a sudden impulse. It's the crystallization of public opinion formed over a long period of time.

We have a booklet which tells about many other good features of Concrete Roads and how they pay for themselves. Simply ask our nearest office to send you a copy.

PORTLAND CEMENT ASSOCIATION

Atlanta
Chicago
Dallas
Denver
Des Moines
Detroit
Helena
Indianapolis
Kansas City
Los Angeles
Milwaukee
Minneapolis
New York
Parkersburg
Pittsburgh
Portland, Oreg.
Salt Lake City
San Francisco
Seattle
St. Louis
Vancouver, B. C.
Washington

Most Miles Per Gallon Means the Concrete Road



BOGALUSA

Trade Mark Reg. U. S. Pat. Off.

STANDARDIZED QUALITY OF

EXTRA DENSE SOUTHERN PINE

"FOR COMPLETE SAFETY SPECIFY 'BOGALUSA' BY NAME."

INDUSTRIAL, RAILROAD AND MARINE REQUIREMENTS

MANUFACTURED, GRADED AND SHIPPED ON A SCALE, AND IN A MANNER, BEFITTING THE WORLD'S LARGEST SAWMILL OPERATION

1,000,000 ft. DAILY—RIGIDLY GRADED AS PER FACTORY MUTUALS, A. S. T. M., A. R. E. A. and SOUTHERN PINE ASSOCIATION

AUTHORITATIVE PINE STATISTICS in "BOGALUSA BOOK," FREE

GREAT SOUTHERN LUMBER COMPANY 1624 FOURTH AVENUE **BOGALUSA, LA.**

Carey Elastite

NAME REG. U.S. Patent Office

EXPANSION JOINT

A. W. Grosvenor, Engineer, builder of this Ft. Wayne, Indiana bridge says —

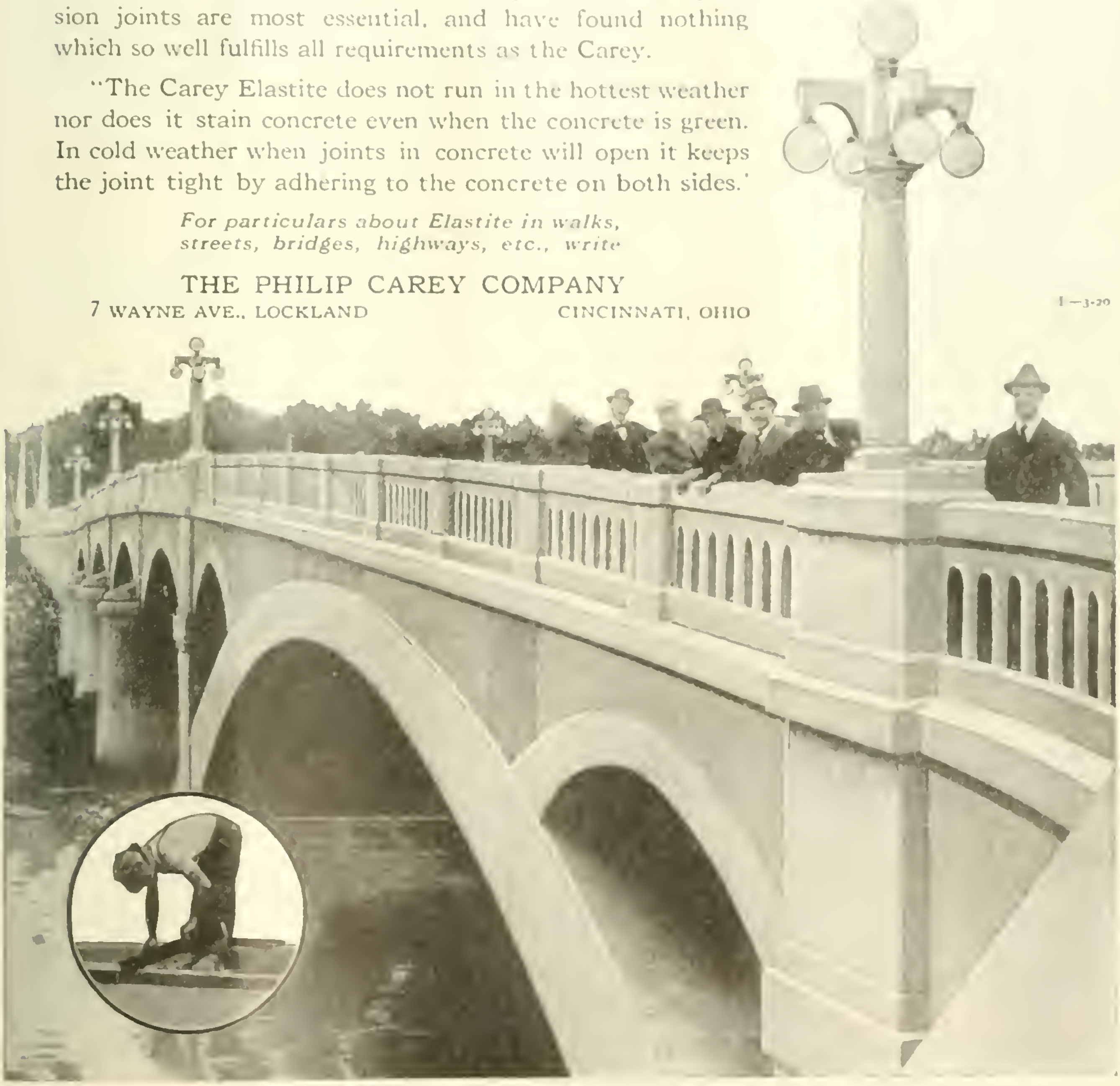
"IN THE PLANS . . . I specified the Carey Elastite for all expansion joints in spandrel walls, copings and on each side of the posts in the hand rails. I have used various other materials in the effort to secure proper provision for expansion and contraction particularly in the spandrels and hand rails of arch bridges in which expansion joints are most essential, and have found nothing which so well fulfills all requirements as the Carey.

"The Carey Elastite does not run in the hottest weather nor does it stain concrete even when the concrete is green. In cold weather when joints in concrete will open it keeps the joint tight by adhering to the concrete on both sides."

For particulars about Elastite in walks, streets, bridges, highways, etc., write

THE PHILIP CAREY COMPANY
7 WAYNE AVE., LOCKLAND CINCINNATI, OHIO

1—3-20



Just Out!

280 pages, 5½x8, $3.00 net, postpaid.

Are you making FULL USE of your bank?

Your bank—do you know it as a department store of finance?

Do you know its many functions which you can use to your profit?

Here is a clear, concise explanation of the modern bank's complicated machinery.

The BUSINESS MAN and HIS BANK

By Wm. K. Kniffin.

This book will tell you what you should know about banking practice in order that you can make full use of your bank in the promotion of your business.

How to

- —choose a bank.
- —prepare financial statements.
- —read bank statements.
- —use trade acceptances.
- —make warehouse and collateral loans.

Throughout the book the treatment is simple, clear, direct. Examine this book.

See it for 10 days FREE.

Free Examination Coupon

McGraw-Hill Book Co., Inc., 239 W. 39th St., New York.

You may send me on 10 days' approval Kniffin's The Business Man and His Bank $3.00 net, postpaid.

I agree to pay for the book or return it postpaid within 10 days of receipt.

Member [illegible] E.?

Signed

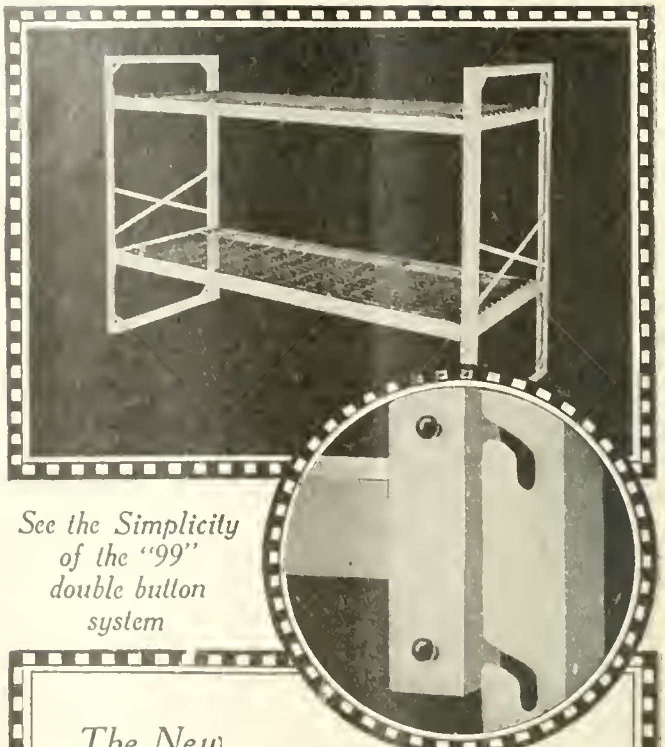
Address

Official Position

Name of Company

(Books sent on approval to retail customers in the U. S. and Canada only.)

E.C. 12-29-20



See the Simplicity of the "99" double button system

The New "99" Solves the Bunk-House Question

THE most ignorant workmen can erect the new all-metal bunk "99". Simply slide the spring-frame into place and the new double-locking button system locks the whole bunk automatically.

For the next job there is no need to waste carpenter's time in building wooden bunks. The cheapest men in the crew can set up the "99". Altogether, Romelink "99" is the strongest, most comfortable and most economical bunk system for railroads and contractors.

It pays to put in a Romelink "99" for the comfort of your men. But it also pays in dollars and cents because the bunk lasts from job to job.

Send for detailed information on this new Romelink product

Southern-Rome Co.

Branch of Rome Metallic Bedstead Company

621 W. Pratt St., Baltimore, Maryland

ROME LINK "99"

EDWARDS

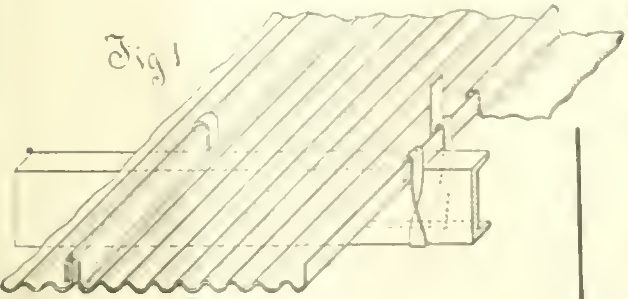
Rolling Steel Doors
Corrugated Steel Roofing
Forged Steel Trucks

Built for Strength and Durability

For convenience of operation, and for economy of installation and maintenance, owners and builders who have given the subject careful study are equipping the doorways in both old and new plants with

Edwards Rolling Steel Doors

They are made of heavy cold rolled steel, bright galvanized, and may be had in the corrugated or interlocking slat type. Patented Spring release Mechanism causes door to close automatically in case of fire. Doors have been designed and successfully operated for openings of all sizes up to 40 feet wide and over 100 feet high



EDWARDS
Patented Pressed Standing Seam Corrugated Steel Roofing

Made in Number 16 to 28 Gauge, Painted or Galvanized.

Can be applied on iron purlins without nailing, riveting or puncturing the metal.

The Ideal Fireproof Roof Covering for Factories, Foundries, Warehouses, Railroad Sheds, Auditoriums, Public Buildings, etc.

Descriptive booklet sent free on request

Uncle Sam Endorses

EDWARDS FORGED STEEL TRUCKS

These are the trucks that the U. S. Government ordered—150 of them—for use in Panama. And if ever any job called for hard, gruelling work, day in and day out, it surely was here.

One continuous piece "U" shaped frame supports the wheels. The upper part of the continuous "U" frame gives perfect rigidity and strength.

EFFICIENCY, DURABILITY AND ECONOMY

Are necessary factors to a truck—particularly where many trucks are used. Edwards Trucks seem to have first call where heavy freight is handled by railroads, steamship lines, warehouses, machine shops, packing-houses and wherever else heavy duty is the order of the day

Write for Descriptive Folder and Prices

THE EDWARDS MANUFACTURING COMPANY

327-377 Eggleston Avenue
CINCINNATI, OHIO

Metal Roofing, Metal Ceilings, Portable Buildings, Steel Trucks, Etc.

HOOL

CONCRETE ENGINEERS' LIBRARY

This great series consists of 4 volumes—
Vols. 1, 2 and 3 of

**Hool's Reinforced Concrete Construction,
and Hool and Johnston's
Concrete Engineer's Handbook**

$20.50 per set payable in seven installments

The whole story of concrete is in these four books. They contain information and data that will help you to overcome every problem in concrete construction that confronts you.

Get Hool's advice. Apply it. If it is what you have been looking for—the help you need every day—keep the books and pay for them while you use them. **Examination is free.**

Sent on approval
NO MONEY DOWN
Small monthly payments

FREE EXAMINATION COUPON

McGraw-Hill Book Company, Inc., 239 West 39th St.,
New York.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

E. C. 12-24-20

Use this Catalog when you need Drawing Materials

It is a good book to just have around.

It is more than a catalog. It is a *reference* book.

The clear, concise descriptions and clean-cut illustrations make it an easy matter to select, immediately, the papers, scales, instruments, etc., that are *best* for your particular work.

DIETZGEN
10th Edition Catalog saves and aids

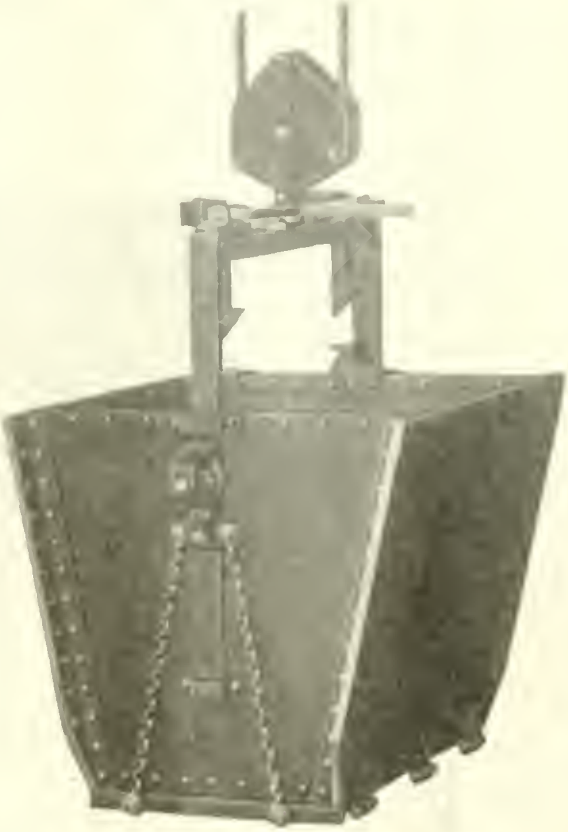
It illustrates and describes our very complete line of Drawing Materials, Surveying Instruments and Measuring Tapes. These goods have quality, workmanship and design that are the result of 27 years of manufacturing experience.

Perhaps you have a copy;
if not, write for one today.

EUGENE DIETZGEN CO.
Established in Year 1893

Branches:	Chicago New Orleans	New York Pittsburgh	San Francisco
Sales Offices:	Philadelphia	Washington	
Factory:	Chicago		

A New Bucket for Concrete Work



[illegible]

HAVE you fully considered the possibility of using an automatic bottom dump bucket for placing concrete work?

The American type B Bucket, illustrated to the right, is peculiarly adapted for this work.

The fact that this bucket discharges its contents whenever and wherever you set it down, and at no other time or place, is of special interest to those who place large quantities of concrete.

The type B bucket is well designed and substantially constructed of heavy steel plates and rolled shapes; the operating mechanism is simple and purely mechanical. It can be operated from either a cable way or monorail trolley, swing derrick, or locomotive crane.

Regardless of where you use it, or what you handle—It Always Works.

Furnished in four sizes, either with a sheave, as shown in the accompanying illustration, or with a forged steel ring for receiving a crane hook.

Investigate this Bucket for your work. For additional information, sign the coupon.

Conveyors Corporation of America

Formerly

American Steam Conveyors Corporation

CHICAGO
326 W. Madison Street

NEW YORK
110 W. 40th Street

CONVEYORS CORPORATION OF AMERICA
Chicago New York

[illegible]

[illegible]

Company

[illegible]

[illegible]

City State

Pakful Filing Cases

Will Hold More, in Better Condition,
Than Any Other Filing Cases Made

They do it without the use of holding-down wires or spring covers. They are absolutely dust-proof and neat in appearance.

The Drawers Are Interchangeable

No matter how full the drawers may be packed with tracings and blue-prints—so that not one more can be entered—they cannot slip over the back nor become rumpled.

The patented features of our cases cannot be appreciated until after one of our cases has been put to the test. Tracings and blue-prints are always found in the same order and condition as last placed.

Let us send you our literature.

Economy Drawing Table & Mfg. Co.
ADRIAN, MICH.

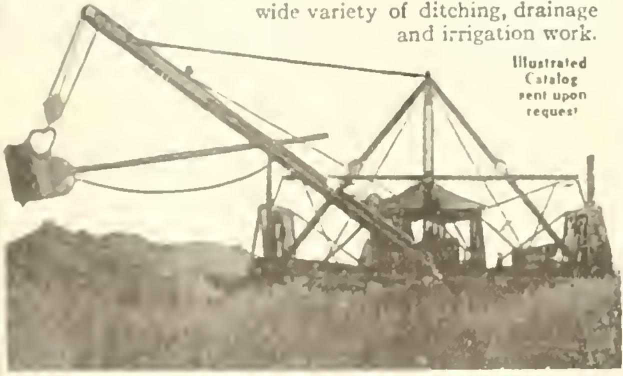
DIG AT A PROFIT IN ANY SOIL
WITH A

Bay City Land Dredge

All structural steel framework, quick-operating and self-propelling. Oil engine power insures low fuel cost. The Bay City is low in cost for installation, moving, repairs, fuel and labor.

Your needs will be fully met by one of the three types: Track Type Land Dredge, the fast-moving "Walking Traction," or the Floating Dredge. Easily assembled and transported, the Bay City is adaptable to a wide variety of ditching, drainage and irrigation work.

Illustrated Catalog sent upon request



BAY CITY DREDGE WORKS
2611 Center Avenue Bay City, Michigan

LITTLEFORD

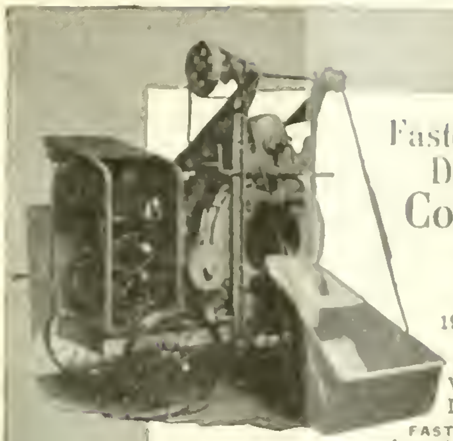
Portable Heating Equipment

FOR CONTRACTORS
AND MUNICIPALITIES

Tar Heaters
Fire Wagons
Tool Heaters
Lead Furnaces
Mastic Heaters
Gravel Heaters
Patrol Heaters
Asphalt Heaters
Distributing Tanks
Combination Heaters
also
Pouring Pots

WRITE FOR OUR COMPLETE CATALOGUE

LITTLEFORD BROS.
450 E. Pearl St. Cincinnati, Ohio



Faster Discharging Concrete Mixers

FOUR BIG 1920 FEATURES THAT OVERCOME "HIGH WAGE" PROBLEM.

FASTER CHARGING—Large drum openings—non-choking hoppers that are steep enough to dump self without pounding.

FASTER DISCHARGING—7 to 16 second discharge through patented action—every bucket discharges—easy to clean.

BROKEN GEARS AND LOOSE CHAINS ELIMINATED—Steel roller pinion drive runs smoother—quieter and saves power—tooth replaced in 4 minutes without taking pinion off shaft.

BEARINGS GUARANTEED FOR LIFE OF MIXER—Hyatt Roller Bearings—save 17% power—70% of oil.

Built in sizes to fit all jobs; ½, 1, 2, 3, 4 Bag Capacities; Gas, Steam, Electric.

$325.00 Buys Our ¼ Bag Low Charger
WITH NOVO ENGINE

One of the many real bargains in our big catalog.

CONTRACTORS' HOISTS

With Hyatt Roller Bearings

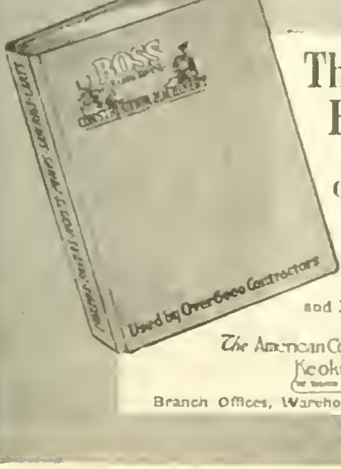
BOSS GASOLINE ELECTRIC HOISTS

Commands the Largest Sales of any Gasoline Hoist. Over twenty car loads sold in one order shipped to France.

Widely used for MATERIAL ELEVATORS, PILE DRIVING, EXCAVATING, DRAG LINES, CONCRETE TOWERS, GENERAL CONSTRUCTION WORK.

BUILT IN 7 SIZES—Single or Double Drum—Reversing or Two Speed if Wanted.

1920 Features S.F.K. Ball Bearing Thrusts. Hyatt Roller Bearing. Machine Cut Steel Engine Pinions. Steel Frames.



The Nation's Price Maker on Construction Machinery

Write for Your Copy Today and New 1920 Prices and Terms.

The American Cement Machine Co. Inc
Keokuk Iowa

Branch Offices, Warehouses in All Principal Cities

---

5 New McGraw-Hill Books

SENT ON APPROVAL NO MONEY DOWN

See any of these books for 10 days' FREE—Use the coupon below

1 *Agg's*
AMERICAN RURAL HIGHWAYS
135 pages, 5[illegible] x [illegible], illustrated, $2.00 net

A textbook for agricultural engineers, students in agriculture, and students in extension courses. It points out the relation of highway improvement to national progress and indicates the various problems of highway administration. It describes the usual methods of highway design and construction in sufficient detail to enable the reader to appreciate the distinguishing characteristics and the relative serviceability of each of the common types of roadway surface.

2 *Agg's*
CONSTRUCTION OF ROADS AND PAVEMENTS
New second edition. 463 pages, 6x9, 116 illustrations, $4.00 net

A concise presentation of approved practice in the construction of roads and pavements, and of the principles involved. It covers selecting, testing and assembling materials, and incorporating them in the roadway surface.

3 *Knowles'*
INDUSTRIAL HOUSING
408 pages, 6 x 9, 54 illustrations, $5.00 net

Industrial firms all over the country are taking decided steps to house the workers. *Who will build the houses?* Here is the only adequate treatise that will give you a clear vision of the opportunities industrial housing will bring you.

4 *Gillette's*
EARTHWORK and ITS COST
Third Edition. 1,346 pages, pocket size, flexible, illustrated, $6

Every phase of such work is carefully analyzed. Detailed cost data on every operation are so presented that by proper rate substitution they may be used by engineers and contractors as cost formulae under all conditions.

5 *Simon's*
DREDGING ENGINEERING
182 pages, 6 x 9, 57 illustrations, $2.50

The first comprehensive treatise covering the construction and operation of the principal types of dredges. Modern dredging problems are carefully planned and worked out.

Free Examination Coupon

McGraw-Hill Book Company, Inc., 239 West 39th St., New York

You may send me on 10 days' approval

I agree to pay for the books or return them postpaid within 10 days of receipt.

Member Amer. Soc. C. E.?

Signed

Address

Official Position

Name of Company

(Books sent on approval to retail customers in U. S. and Canada only.)

E. C. 12-29-20

The Wilson Walker

Will take your STEEL LAND DREDGE just where you want it to go. Will move in a straight line or turn any curve and will back up as easily as it goes ahead.

Operated by ONE MAN from DECK of DREDGE. This WALKING DEVICE permits the use of a LONGER BOOM and a LARGER DIPPER and no tip up of rear axle.

It gives a positive move of a foot, five feet or fourteen as you may need.

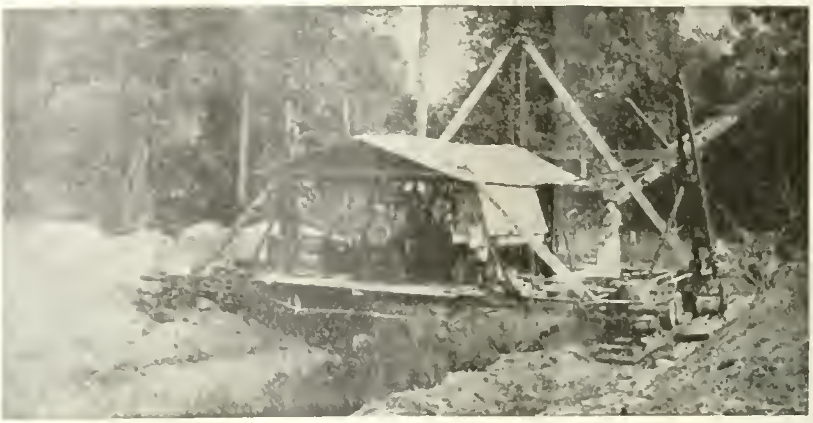
We want you to see THE WILSON WALKER in operation, then you will know, first hand, why it is the one you have been waiting for.

It is protected by patents.

Ask for further details.

Wilson Walker Company

205 N. Kiesel Street Bay City, Michigan



The Wilson Walking Device Is Protected by Patent

"Ten Minutes to Set Up That Storms Culvert Frame

The bracing of a 10 foot culvert in place in ten minutes. Think of that Contractors and Highway builders!

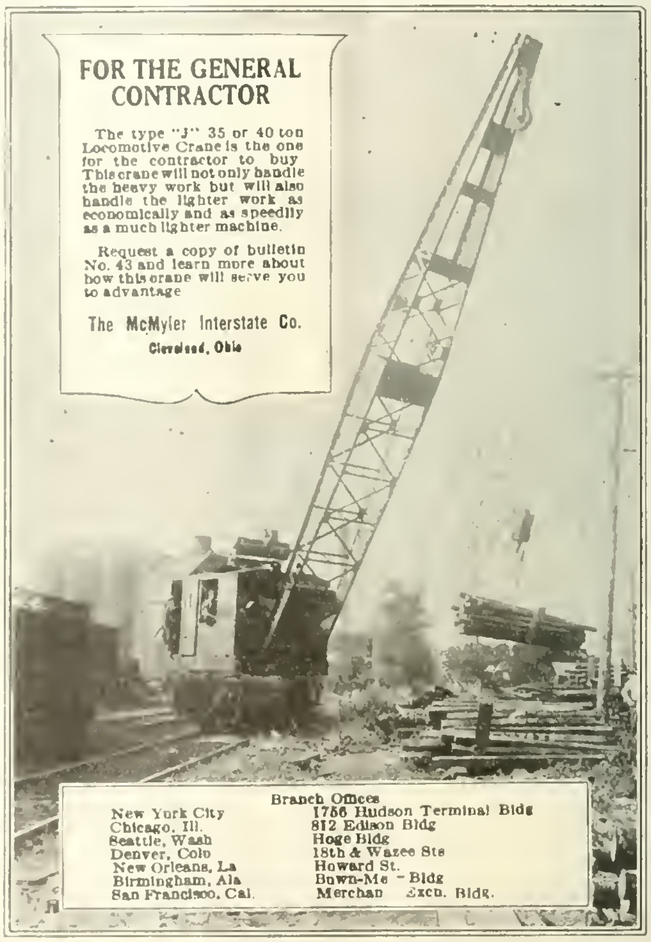
Are you wasting two to three hours and a lot of expensive lumber to do what you can do in ten minutes with the

STORMS ONE-MAN
Collapsible Culvert Frame

[illegible] ADJUSTABLE too—no need for a different frame for every different size of culvert [illegible] lumber bracing. Made of STEEL—can't sag or bulge. No steel casing. No loose parts to get lost. A pull collapses it and your form lumber comes away undamaged and your culvert is cleared quicker than you can [illegible] lumber bracing. In use on the highways of a dozen states. Write for folder E-C's [illegible] complete cost data.

STORMS MFG. CO., Crawfordsville, Ind.

STORMS



FOR THE GENERAL CONTRACTOR

The type "J" 35 or 40 ton Locomotive Crane is the one for the contractor to buy. This crane will not only handle the heavy work but will also handle the lighter work as economically and as speedily as a much lighter machine.

Request a copy of bulletin No. 43 and learn more about how this crane will serve you to advantage

The McMyler Interstate Co.

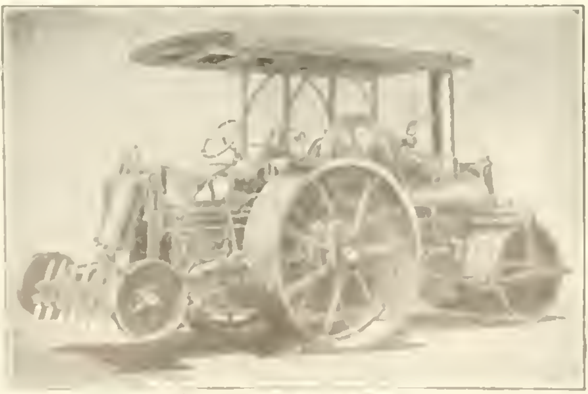
Cleveland, Ohio

Branch Offices

New York City	1756 Hudson Terminal Bldg
Chicago, Ill.	812 Edison Bldg
Seattle, Wash	Hoge Bldg
Denver, Colo	18th & Wazee Sts
New Orleans, La	Howard St.
Birmingham, Ala	Bown-Me - Bldg
San Francisco, Cal.	Merchan Exch. Bldg.

Have you our catalog?

Send for a copy today.



Roller with Pressure Scarifier

THE STANDARD ROAD BUILDERS OF AMERICA

Buffalo Pitts and Kelly-Springfield Rollers

They have made a record for long life, reliability and efficiency that is unequalled. Time and heavy traffic have made road maintenance an important question. Our Pressure Scarifier attachment does excellent work in loosening Macadam and other surfaces and preparing them for resurfacing. Made in all types and sizes.

The Buffalo-Springfield Roller Company

SPRINGFIELD, OHIO

GEAR AND FRICTION DRIVEN GASOLINE LOCOMOTIVES—2½ TO 25 TONS ON DRIVE WHEEL

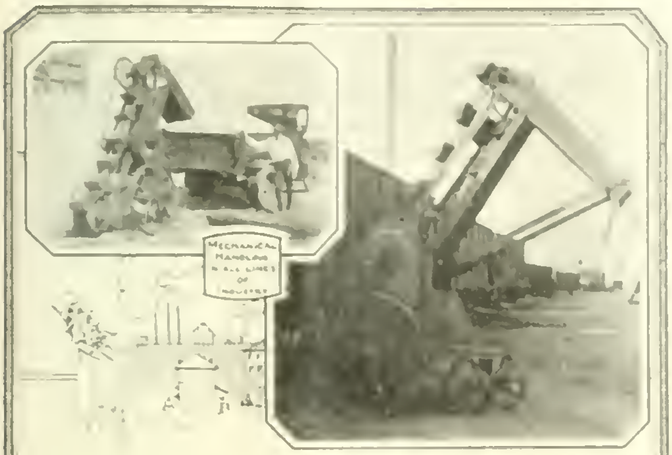
WHITCOMB LOCOMOTIVES

IT WILL PAY YOU TO GET OUR PROPOSITION BEFORE YOU BUY

GEO. D. WHITCOMB CO.

MAIN OFFICE AND WORKS
ROCHELLE, ILLINOIS
U. S. A.

STORAGE BATTERY LOCOMOTIVES—1 TO 8 TONS ON DRIVE WHEELS



Reducing the Cost of Handling

coal crushed stone, sand, gravel, or any other loose material—is accomplished by the use of G-W Wagon Loader and Loading Equipment

Order your loader today

Designers and Manufacturers of Elevators, Conveyors, Hoppers, Screens, Chutes, Buckets, Etc.

Gifford-Wood Co.

NEW YORK CHICAGO
MAIN OFFICE AND WORKS HUDSON, N.Y.
BOSTON BUFFALO

Seaverns Locomotive Crane

10 TO 30 TONS CAPACITY

FAST POWERFUL SIMPLE

MADE OF BEST MATERIALS POSSIBLE

MANUFACTURED IN CHICAGO BY

JAMES B. SEAVERNS

122 South Michigan Ave. Telephone Harrison 6726

One of the fundamental principles of selling anything is to offer that thing for sale in a logical market.

Engineering and Contracting

affords a logical market for every kind of civil engineering or engineering-contracting equipment and supplies.

Advertising Rates on Request

Engineering and Contracting

608 So. Dearborn St. Chicago

Premier Construction Co Indianapolis, Ind 1800-yd Plant

CUMMER ASPHALT PLANTS

(Portable and Stationary)

Three sizes 750, 1250 and 1800 sq yds. 2" top or equal of other bituminous pavement per day.

Over two hundred references. GOOD DELIVERIES.

Cummer Plants Never Wait for Hot Sand

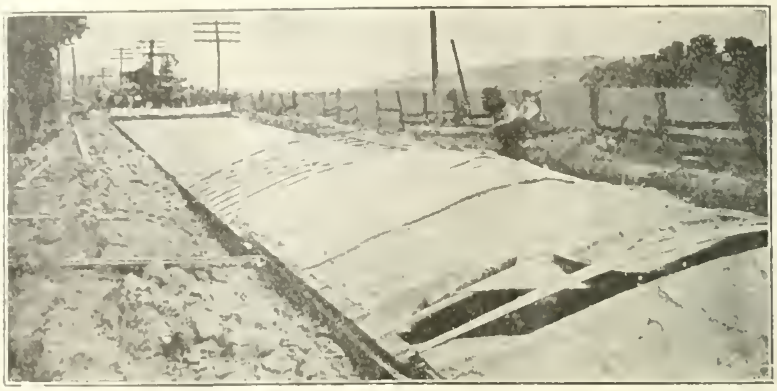
The F. D. Cummer & Son Co.

Cleveland, Ohio
New York Office: Berkeley Bldg., 19 West 44th St.

Protect Your Concrete
Construction Work Against Freezing

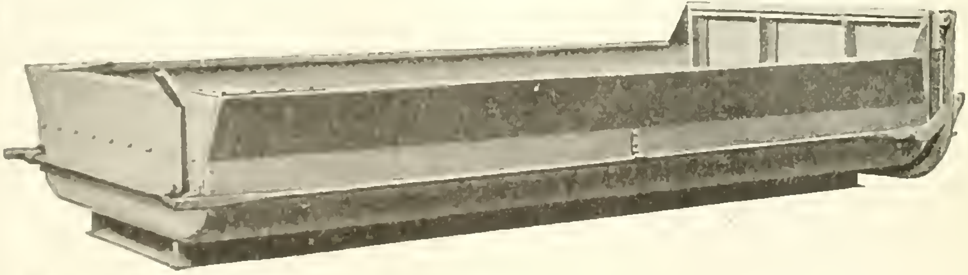
Cover the Finished Job
With Waterproof Canvas

Let us fill your needs in correctly made quality covers.



913-915 Walnut St. **Des Moines Tent & Awning Co.** Des Moines, Iowa

---



For Rapid Operation and Durability—

Standard Steel Dump Bodies speed up any kind of hauling. They save time and labor and increase profits. Correct in design, light but strong, and built for long life. There's nothing but QUALITY in

STANDARD Steel Dump Bodies

Type D-2 illustrated here is made of No. 10 steel throughout in 1½ and 2-yard capacities; 3/16-inch steel plate in 2½ to 6-yard capacities. I-beam sill. Staunchly braced and cross braced throughout. We recommend this body particularly for road contract work. Correctly proportioned and of pleasing design. Adaptable to any size or make of truck.

Type D-2 is one of a COMPLETE line of Standard Steel Dump Bodies ready to ship. We also make bodies to specifications for special uses. Send name and address—a card will do—for the new Standard Catalogue and price lists.

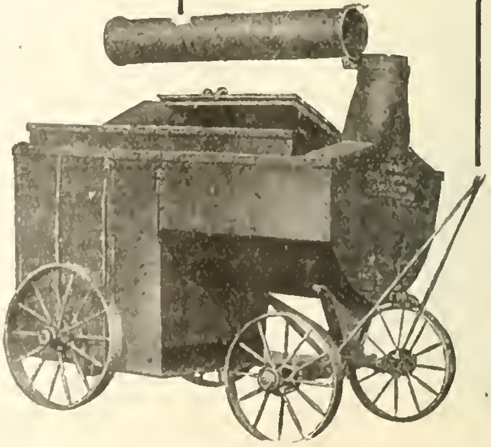
STANDARD STEEL WORKS

1724 Tracy Avenue - - KANSAS CITY, MO.

ROAD KETTLES THAT "STAND the RACKET"

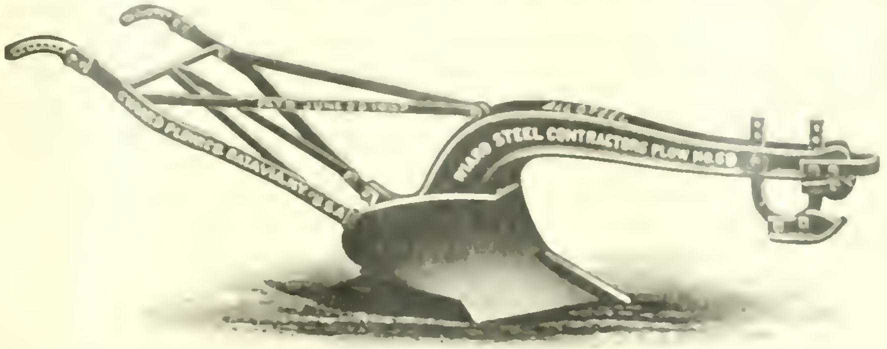
Roadworkers' kettles and heaters are always ***ahead*** of the good roads movement. They must stand up under rough usage. That describes Standard Steel Kettles and Heaters. They ***last.*** Heaters in various sizes up to 500 gallons. Mounted or unmounted. We can furnish kettles, buckets and pavers' pouring spouts of any style or capacity, and made to stand the racket of the road for years. Ask for illustrated descriptions and prices. A post card will do.

SEND IT NOW.



WIARD

ROAD AND CONTRACTORS' PLOWS


WIARD STEEL CONTRACTORS PLOW NO. 69
WIARD PLOW CO. BATAVIA, N.Y. U.S.A.

For all Road or Contractors' work—for tearing up cobblestones and macadam—**it can be used as a perfect Rooter and Pavement** Plow by simply removing the steel wing below the moldboard—thus making **a two in one** Plow for all around work.

Ordinarily, the contractor has one plow for general purpose or furrow work and another plow for rooter work or tearing up old pavements.

This No. 69 does the work of both and answers for any and all purposes, means a less investment and keeping in stock extra parts for one plow only.

The Plow is intended for use with either animal power, a traction engine or road roller and is very simple in construction, consisting of only nine parts aside from the braces and bolts.

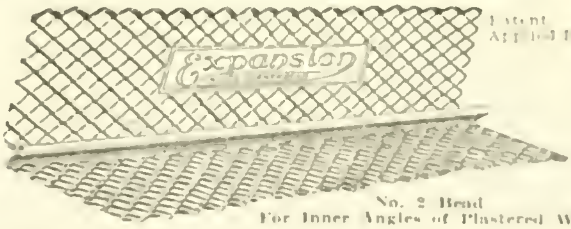
Catalog and prices furnished on request

THE WIARD PLOW COMPANY
Batavia, N. Y. U. S. A.

Clips Unnecessary with Expansion Beads

Patent Applied For

No. 1 Bead
For Outer Angles of Plastered Wall



Patent Applied For

No. 2 Bead
For Inner Angles of Plastered Wall

THE new and exclusive feature of EXPANSION Corner Beads is the use of Expanded Diamond Mesh reinforcement in the wings or webs instead of practically solid members as heretofore universally used.

The unusual width of web in EXPANSION Beads—approximately three inches—permits of their being fastened in any position **without the use of clips.** Because of their uniform continuous fastening surface they may be wired, nailed, stapled or stuck to any kind of building material at points which offer the most convenient and stable attachment.

STOPS FIRE
AND PREVENTS CRACKS

EXPANDED DIAMOND
TRADE NETMESH MARK
METAL LATH

The Best Backing for Interior Walls or Stucco Overcoating

NO. 2 EXPANSION Bead combines with the merits of No. 1 Bead, a ground to which the mechanic may work, insuring correct lines and saving labor. This Bead is a great advance over the strip of metal lath heretofore used to strengthen inside angles and is furnished in lengths up to 12 feet; providing continuous reinforcement from floor to ceiling.

This latter combination will appeal strongly to the Architects and Contractors who are weary of the sight of cracked corners.

EXPANSION Beads are designed to take the place of metal lath strips in many [illegible] in a building. Made of [illegible] Open Hearth Sheets in 8, 10 and 12 ft. lengths. Crated in 1,000 ft. lots. Weight per 1,000 ft. 240 pounds.

"Invisible Joint" Metal Ceilings and Side Walls

"Milcor" Base Screeds and Picture Moulds

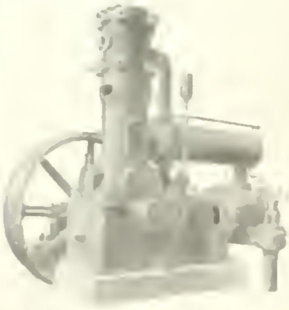
"Superior" Corner Beads

MILWAUKEE CORRUGATING CO.
MILWAUKEE
KANSAS CITY MINNEAPOLIS

Metal Roofing of All Kinds

"Titelock" Metal Shingles and Tile

"Milcor" Building Corners and Brick Bands



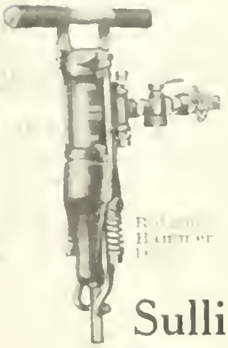
Compressed Air Engineering

THE adaptability of compressed air to new uses, and its flexibility, convenience and effectiveness, render it a most attractive and economical form of power for many industrial purposes.

The Sullivan Machinery Company stands ready to serve users of compressed air in the capacity of Air Power Engineers.

The advice of Sullivan engineers is available alike to those planning the purchase of compressors or pneumatic machines, and to those who have problems of air power use and distribution to solve.

The experience and knowledge of this company, covering half a century, gained in the manufacture and use of air compressing and air using machinery, fit it particularly to act in this engineering capacity.

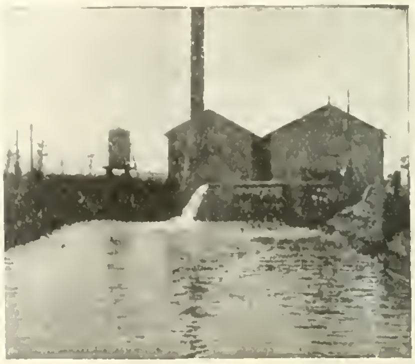


Descriptive matter will be furnished upon request on Sullivan Products:

Air Compressors
Air Lift Well Pumps
Vacuum Pumps
Hammer and Rock Drills
Diamond Prospecting Drills
Forge Hammers
Drill Steel Furnaces
Coal Mining Machines
Stone Quarry Machinery

Inquiries of any sort relative to the use of air power are solicited and will receive prompt and intelligent attention.

Sullivan Machinery Company
130 So. Michigan Ave., Chicago 30 Church St., New York, N. Y.



Air Lift Pumping

FAIRBANKS-MORSE "Z" ENGINES

Practical Power for Pumping

This "Z" engine drives a pump on a bridge construction job—one instance of the adaptability of this steady, economical engine to the contractors' needs.

Bosch high tension magneto-throttling governor—interchangeable parts—low center of gravity—uses kerosene as well as gasoline. Sizes 1½ to 20 H. P.

For driving concrete mixers, conveyors, crushers, hoists, painting machines, pumps, sand blast machines, saw rigs, tiering machines, etc.

Fairbanks, Morse & Co.
MANUFACTURERS CHICAGO

Oil Engines - Pumps - Electric Motors and Generators - Fairbanks Scales - Railway Appliances - Farm Power Machinery

Two Men Doing the Work of a Four Team Outfit

Send in your name and we will write you where you can see this plant in operation also a large number of Power Drag Scraper installations handling gravel to plant, wagon, or car loading, stripping, and grading. Any material from soft mud to the hardest kind of clay

This scraper handles considerably more material with the same labor and power than any other excavating tool on the market, which means a positive reduction in both installation and operating expense.

L. P. GREEN

ARROW POWER DRAG SCRAPER

907 Lumber Exchange Bldg. Chicago, Illinois

HAVE FOR SALE 1 used slackline excavator complete, 9 x 12 hoist, 1½ cu. yd. bucket

---

QUALITY

Kinney

EFFICIENCY

KANT KLOG

NO STEAM REQUIRED FOR HEATING
NO DANGER OF INJURY TO MATERIAL
NO CLOGGING OF NOZZLES
SIDE CONTROL OF SPRAY

KANT KOKE

Patent Combination

Auto Heater and Distributor at Work

Auto-Heater and Distributor

that meets the test of hard service.

When not required for Road Oiling the tank and entire oiling attachment can be removed, and the truck used for other purposes.

Kinney Equipment holds particular interest for Road Builders, Contractors, Municipalities and all others who wish to save Time, Labor and Money.

Whether your material is hot or cold, an even, uniform distribution is maintained at all times. Extended spray pipes may be used for wider distribution, as desired.

For Heating and applying under Pressure all varieties of Bituminous Materials Hot or Cold, for Road Construction or Maintenance or Dust Laying.

Heat and volume under instant control of operator.
Positive pressure produced by the Kinney Pump

Kinney Manufacturing Company

BOSTON, MASSACHUSETTS

New York
Philadelphia
Philippine Islands
Chicago
Pittsburgh
Porto Rico
Cuba
Kansas City
San Francisco
Hawaiian Islands

SPRACO

PAINTING EQUIPMENT

THE SPRACO PAINT GUN

(It's the *better* gun)

It is not an ordinary paint gun.

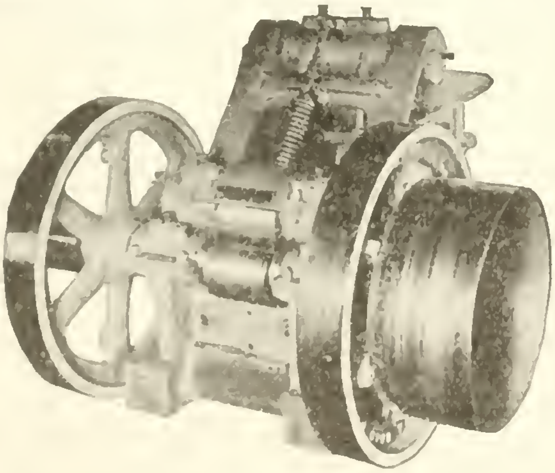
It not only does the work in one-tenth of the time and at one-tenth of the cost of the old hand brush method, but it is designed to do the work **better,** and does it.

Write for Bulletin No. P-15

SPRAY ENGINEERING COMPANY, Boston, Mass.

Manufacturers also of Spraco Air Washers and Cooling Ponds, Spraco Cement Sprayers, Spraco Nozzles, Vaughan Flow Meters, Etc.

SPRAY ENGINEERING CO. BOSTON, MASS.



IF YOU ARE LOOKING FOR DURABILITY AND LOW COST OF MAINTENANCE your natural choice will be the

RELIANCE

"The Crusher with the LONGER LIFE"

Write for catalogue and prices on our complete line of Quarry and Road Building Equipment. Prompt deliveries.

UNIVERSAL ROAD MACHINERY CO.
KINGSTON, N. Y.

Canadian Representatives:
F. H. Hopkins & Co.—Montreal and Toronto

DAVENPORT

Gear-Drive Locomotive

Powerful—Quick Acting—Smooth Running—Speedy

Reliable Locomotive for Industrial Switching of all kinds. **ONLY TWO GEARS NO BEVEL GEARS.** Especially suitable for use on Light Rails—Steep Grades—Sharp Curves—Rough Track. All sizes—Four and Six Wheel types

DAVENPORT LOCOMOTIVE WORKS, Davenport, Iowa

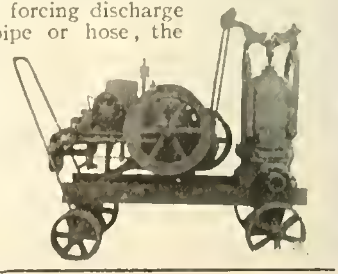
Builders of all types of Road Locomotives, Gear Drive Locomotives, Locomotive Cranes

---

"Domestic" Power Diaphragm Force Pump Unit

This Outfit Is Desirable for Two Classes of Work

For pumping out excavations, sub-cellars, trenches, etc. when the vertical distance from suction source to discharge point is over 25 feet and under 40 feet. By setting unit near the bottom and forcing discharge through line of 3-inch pipe or hose, the maximum discharge is obtained.



The pump is odorless and sanitary in removing the contents of cesspools, catch-basins, etc., where closed haulage tanks are employed.

The engine is a "Domestic" Special Integral Gear Pumping Engine, and has ample power to operate the pump without strain at maximum load. Catalog will be sent free on request.

Domestic Engine & Pump Co.
Shippensburg, Penna.

KOPPEL

"Like the Last"

A true evidence of the worth of a car can be measured by its popularity with its users.

SALES OFFICES:
50 Church St.,
New York City
Peoples Gas Bldg.,
Chicago.
Farmers Bank Bldg
Pittsburgh
Edw. R. Bacon Co.
51 Minna St.,
San Francisco.
1420 Chestnut St.,
Philadelphia
Book Building,
Detroit.

We have received many repeat orders on this car—all specifying "like the last"—which means that users appreciate its lightness, strength, and ability to stand up.

We offer a rental proposition that may appeal to you. Write for it.

TRADE MARK REGISTERED
KOPPEL
U.S. PATENT OFFICE

KOPPEL INDUSTRIAL CAR
& EQUIPMENT COMPANY
KOPPEL, PA.

MERRIMAN ASPHALT PLANTS
HELP YOU TO GET BETTER CONTRACTS

Good engineers are specifying steam melted asphalt because it is absolutely safe, gives better results and lasts longer. The steam melting system also saves money for the contractor because it makes it impossible to burn or coke the asphalt or burn the kettle bottoms. The complete plants are built in our factory by skilled mechanics — built to do real work and keep on the job.

The car measures 55 ft. over all. Plant is easy to dismantle and set up. Has extra large hot material bin and large mixer. Two melting kettles—a day's run in each. Each unit can be operated separately.

Write for folders, giving capacities, testimonials and full information

The East Iron & Machine Company
354 E. Market Street - - - - LIMA, OHIO, U. S. A.
Philadelphia Office, Transportation Building

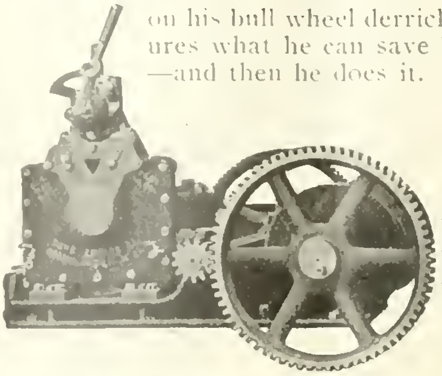
LIDGERWOOD HOISTS
STEAM ELECTRIC GASOLINE
For Every Type of Contracting Work
A HOIST FOR EVERY PURPOSE
Catalog Upon Request
LIDGERWOOD MFG. CO., 96 Liberty St. NEW YORK

THE WISE CONTRACTOR

doesn't waste any time considering what it costs to install

DAKE SWINGING ENGINES

on his bull wheel derricks. He figures what he can save by doing it—and then he does it.



4 Sizes:
No. 3 -- 5 h.p.
No. 3½ --7 h.p.
No. 4--10 h.p.
No. 5--15 h.p.

A Dake means greater speed and efficiency. The reversible engine with no dead centers gives perfect control of the boom. No clutches. No delays. Eliminates unnecessary lost time, and reduces expensive repairs to a minimum.

Ask the man that uses a Dake. He knows. Write us for full information and particulars.

DAKE ENGINE CO., Grand Haven, Mich.

HAISS WAGON LOADERS

1 cu. yd. in 1 minute for 1c with 1 man

The Great "Path Digging" Type

Self-Feeding—Self-Propelling—Self-Crowding

Success in this business depends upon machinery! Here is YOUR opportunity; hire a sand bank, buy a few wagons and a Haiss Self-Feeding Truck Loader, after that competition won't worry you. New Booklet No. [illegible] is free; it tells how to solve a Problem in Profits. Write for it on business stationery.

THE GEO. HAISS MFG. COMPANY
143rd St. and Canal Place NEW YORK CITY

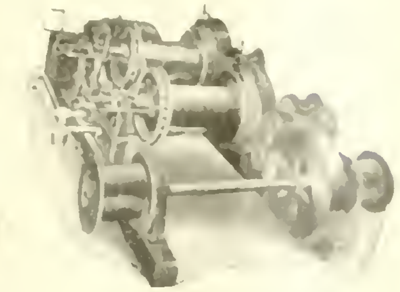
Leschen Wire Rope

Back of every Leschen Wire Rope is a large modern plant operated by skilled workmen and directed by experienced engineers.

If you will tell us how you use Wire Rope we shall be glad to suggest the correct rope for the work.

Established 1857

A. Leschen & Sons Rope Co.
ST. LOUIS, U. S. A.
New York Chicago Denver San Francisco



FLORY

Double Drum Electric Hoist
with Swinging Gear

One of the many types shown in Flory Catalogue No. 26.

A Flory Hoist for Every Purpose

DO YOU HAVE
YOUR COPY?

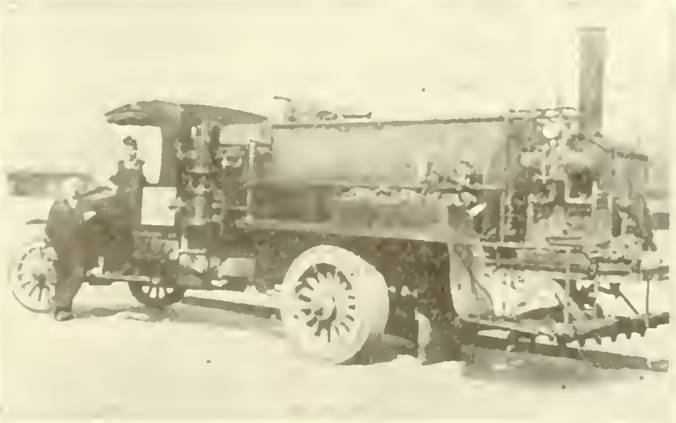
Sent on request. Address nearest office.

S. Flory Manufacturing Company
BANGOR, PENNA.

New York, 95 Liberty Street
Pittsburgh, 1st Nat'l Bank Bldg.
Chicago, Monadnock Block
Hartford, The K. B. Noble Co.

CRESSY AUTOMOBILE ROAD SPRAYERS

Always Prove an Important Part of the Equipment for Road Builders, Contractors, Municipalities



Cressy Automobile Road Spraying Machines are the only machines on the market which can successfully spray asphalt, heavy tar or any other bituminous material now in use for road construction, maintenance and dust laying.

The tank holds from 700 to 1000 gallons and is tested to stand 100 pounds pressure. It is fitted with Steam Coils to heat the material and keep it hot for days, if necessary. It is impossible to burn any material. An Air Compressor is mounted on the side, which furnishes air to discharge the material when the quick-opening valve is opened and which also loads the tank by vacuum.

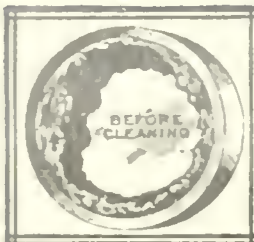
A small boiler mounted on the rear furnishes steam for heating the material, to run the Air Compressor, to thoroughly heat and clean the Spray Pipes. The outfit is mounted on channel iron and is complete in one unit, being fastened to the chassis by U-clamps around the frame.

The Sprayer is entirely self-sufficient. *FULL INFORMATION ON REQUEST*

SOME OF THE ADVANTAGES

Material cannot burn.
No pumps to clog.
Even application
Direct and uniform pressure.
Greatest capacity of volume of work.
Lowest cost of application.
Successful results.
Only machine on the market which will *successfully* spray any kind of asphalt.
The *only* machine that provides a way to heat and clean spray pipes.

CRESSY ROAD SPRAYER MFG. CO.
462 Second Street
Everett, Mass.



Sanitary Water Mains

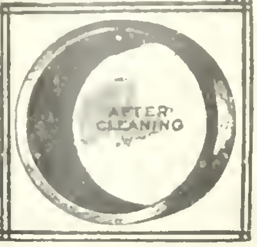
Through the National Method of Cleaning

There is but one reasonable thing to do with dirty water mains. That is to clean them. Rebuilding them will cost many times the expense involved in cleaning by our method, which has for many years past, in the experience of a great number of cities, been proven a highly successful and economical method of cleaning.

Send for descriptive literature

NATIONAL WATER MAIN CLEANING CO.

80 Church St. New York City



Dobbie Derricks and Hoists

Stock of Fittings, Blocks, Sheaves, Winches, etc., carried by our agents—

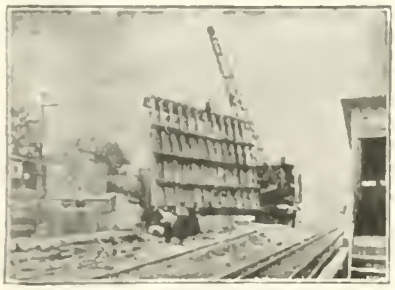
G. S. Green Co., New York.
Beckwith Machy. Co., Pittsburgh.
Beckwith Machy Co., Cleveland.
P. I. Perkins Co., Boston.

DOBBIE Foundry & Machine Co.
Manufacturers
Niagara Falls, N. Y.

O. S. Dependable Locomotive Cranes and Buckets

are unsurpassed for

General Construction Work



Low Maintenance Cost and Efficiency distinguish them.

Orten & Steinbrenner Co.

Shops: Huntington, Ind.

Main Office: Chicago

BURTON

Gasolene LOCOMOTIVES

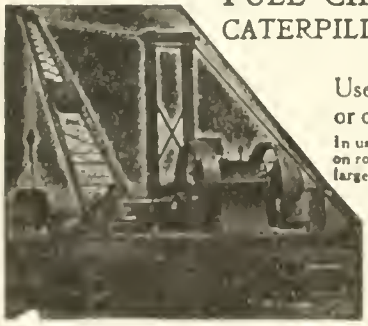
These locomotives are built in 3½ and 6 ton sizes. Their simplicity of construction and operation and their low fuel cost make them a fine investment for any contractor. No licensed engineer necessary. Get in touch with us and begin to save money on *your hauling*.

THE BURTON ENGINEERING & MACHY. CO.
Spring Grove and Alabama Avenue, Cincinnati, Ohio, U. S. A.

Haul it Economically

THE C. L. GADE EXCAVATORS

FULL CIRCLE SWING
CATERPILLAR TRACTION



Used either as dragline or clamshell excavator.

In use on government work, also on roads, drainage, irrigation and large tile.

C. L. GADE
177 MAIN ST.
IOWA FALLS
IOWA

APOLLO-KEYSTONE

COPPER STEEL
Galvanized

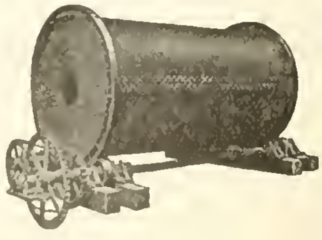
Sheets

Highest in quality and rust resistance. Unequaled for Culverts, Flumes, Tanks, Roofing, Siding, Spouting, and all exposed sheet metal work.

We manufacture Sheet and Tin Mill Products of every description—Black and Galvanized Sheets, Corrugated and Formed Products, Roofing Tin Plates, Etc.

AMERICAN SHEET AND TIN PLATE COMPANY, Pittsburgh, Pa.

John A. Roebling's Sons Co
TRENTON, NEW JERSEY

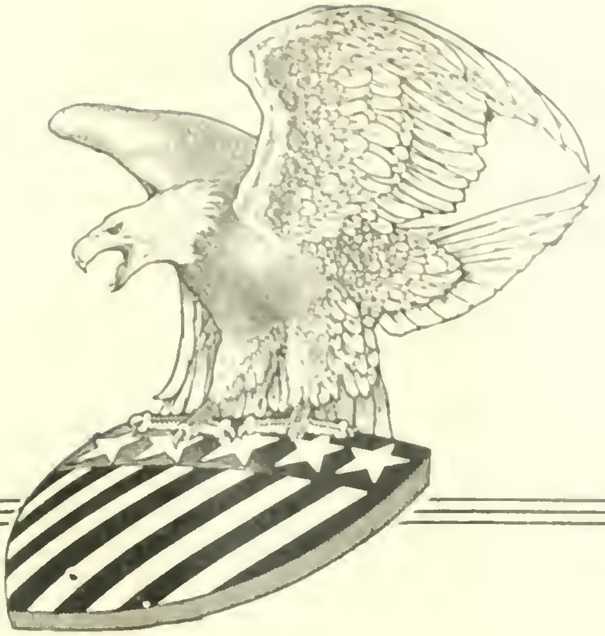


Allis-Chalmers
Stone and Gravel Scrubber

We Design and Equip Complete Gravel Washing, Gravel Crushing, Gravel Screening Plants

Undivided Responsibility

ALLIS-CHALMERS MANUFACTURING CO.
Milwaukee, Wis.



How Much War Department Surplus Property Can Be Absorbed by Your 1921 Contracts?

Nearly one hundred thousand individual orders representing sales amounting to nine hundred million dollars is the staggering total of property disposed of through War Department sales to date.

The buying power of America has responded to these sales in a big way, many big interests looking to them as a regular source of supply.

Thousands of machines purchased through this channel are in operation. Thousands of motors, generators and other electrical equipment are supplying heat, light and power in every industry. Huge quantities of chemicals have found their way to use through these sales. Thousands of tons of iron and steel from this source have been wrought into every conceivable tool and commodity.

NOW IS THE TIME TO VIEW YOUR FUTURE NEEDS

Read Every Item on the Following Pages

WAR DEPARTMENT

"Surplus Property Sales"

Every Item of Perti

Route This Advertisement Through Your O

Eastern Division

13640
4—Push Carts, Concrete, No. 12 U. S. Gauge steel, 10^{9} inches thick, 39 inches long at top, 21¼ ins. wide at bottom, 20 inches deep; Capacity 6 cu. ft
Location—Norfolk, Va.

1084
1275 lbs. Dynamite, 40% low freezing.
Location—Norfolk, Va.

19492
450 lbs. Dynamite, Dupont Red Cross 40-90 strength, 50 bxs.
Location—New York.

13625
92—Hammers, Riveting, steam operating No. 5 "Little David", chipping and parts
Location—Norfolk, Va.

14200
9—Hammers, Riveting, No. 90 with ⅞ in. button head rivet sets, mfd. by Ingersoll Rand Co.
Location—New York.

13631
1—Wright, High Speed Hoist, 4 ton capacity, with 12′ lift.
Location—Norfolk, Virginia.

E-642
29,875 ft. Discharge Hose, 2″ dia., 4 ply, 25 ft. lengths, coupling & clamps attached.
Location—Pittsburg, Pa.

E-643
12,500 ft. Discharge Hose, 2″ dia. 4 ply, 25 ft. lengths., Coupling and clamps attached.
Location—Pittsburg, Pa.

E-644
37,375 ft. Discharge Hose, 2″ dia., 4 ply, 25′ lengths. Coupling & clamps attached.
Location—Pittsburg, Pa.

E-645
20,400 ft. Discharge Hose, 2″ dia., 4 ply, 25′ lengths. Coupling & clamps attached.
Location—Pittsburg, Pa.

---

100 ft. Air Hose, ¾″ wire bound.
Location—Pittsburg, Pa.

E-640
3840 ft. Suction Hose, 2″ d
4 ply, 15 ft. lengths. Coupli
& clamps attached.
Location—Pittsburg, Pa.

E-614
3,510 ft. Suction Hose, 2″ di
4 ply, 15′ lengths. Coupling
clamp attached.
Location—Pittsburg, Pa.

E-892
1—Steel Structural Sha
48″x7′x4′.
Location—Philadelphia, Pa.

E-891
2—Steel Structural Shap
54″x2′x7″-4′.
Location—Philadelphia, Pa.

3510
10,686 "I" Beams, 12′ lengt
4″ width; 7¼ lbs. per ft.
Location—New Cumberland,
Pa.

E-879
2,300 Structural Steel "
Beams, 5½″x3″-9′ long, 5
high, 3″ wide.
Location—Phila, Pa.

List Continued

WAR DEPA

"Surplus Prope

ent Interest

nization So All May Benefit

E-890
191 Structural Steel "I" Beam
15' 6" long x 3".
Location—Phila., Pa.

E-889
27 Structural Steel "I" Beams
2½"x4" 12'.
Location—Philadelphia, Pa.

13667
41—Shelters, corrugated iron metal arch, 32'x9'x7', 11 gauge, elephant type "E". Complete with parts.
Location—Schenectady, N. Y.

Central Division

11102
28—Books level, 4½x7½.
Location—A. R. D., Columbus, Ohio.

11116
107—Books, handbook of plant construction.
Location—A. R. D., Columbus, Ohio.

3406
5—Logging carts, No. 2, New, wheels 9' high, tires 4 x¾", 8' hickory axle, tongue, chains and trap hook, singletrees, evener & neckyoke
Location—Pullman, Ill.

15692
27—Drawing Boards with trestle 23 x31".
Location—Columbus, Ohio

[illegible]67
1—Pile Driver, portable compound gas engine and hoist, Class "A".
Location—A. R. D., Columbus, Ohio.

11984
5—Winches, hand, single drum, 6"x20" bbl. raybestos lined brake with safety strap; double purchase.
Location—A. R. D., Columbus, Ohio.

n Next Page ——————

ARTMENT

rty Sales"

MACHINERY AND ENGINEERING MATERIALS
List No. 13
Sold by Negotiation

HOW TO ORDER

All orders and negotiations for materials offered in this list must be addressed to the Depot Quartermaster of the division where material is located. The divisions and the addresses of controlling offices are given below. To obtain a complete list of materials not listed in this advertisement, clip and mail the attached coupon.

List of Divisions and Controlling Offices

Eastern Division
59th St. & 1st Ave.,
Brooklyn, N. Y.

Central Division
1819 West 39th St.,
Chicago, Ill.

Southern Division
Transportation Bldg.,
Atlanta, Ga.

Southwestern Division
San Antonio, Texas

Northwestern Division
Army Supply Base,
Boston, Mass.

COUPON

Chief, Sales Promotion Section, Office of the Director of Sales, Room 2515, Munitions Building, Washington, D. C.

IMPORTANT
Mail Coupon to This Address

Kindly send M. & E. M. List No. 13..........
in its entirety
Firm Name..........
Street Address..........
City.......... State..........
Signed by..........

Engr. & Contracting

MACHINERY AND ENGINEERING MATERIALS

List No. 13 (Continued)

Southern Division

S. E. 250
1—Hoisting Engine, upright, Class "B" 30"x5'-6".
Location, Oteen, N. C.

S. E. 249
2—Concrete Mixers, Ransom, Class "B".
Location—Oteen, N. C.

S. E. 110
2504 Unions Special. Bet. N Class "A".
Location—Atlanta, Ga.

S. E. 101
203 lbs. G. I. Wire, No. 5, Class "A".
Location—Atlanta, Ga.

S. E. 100
189 lbs. G. I. Wire, No. 7, Class "A".
Location—Atlanta, Ga.

ADDITIONAL ITEMS

from

MACHINERY AND ENGINEERING MATERIALS

List No. 13

TO BE SOLD BY NEGOTIATION

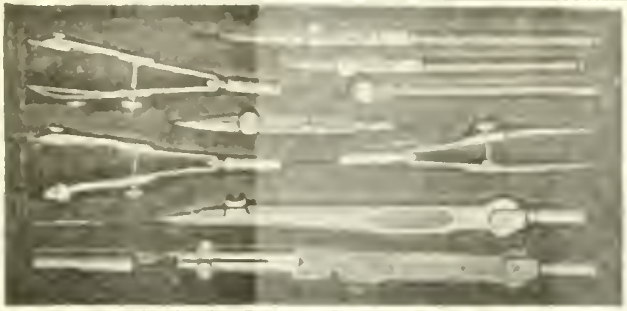
Aneroid Barometers
Canister Bottoms
Compass Boxes
Ratchet Braces
Brass Grommets
Brass Fasteners
Brass Hock Parts
Brass Loops
Brass Rivets
Brass Slides
Brass Studs
Brass Washers
Lead Covered Cable
Telephone Cable
Cable Releases
Calipers
Canvas, O. D.
Compass Watches
Condensers
Reducer Connections
Conveyors
Cylinders
Duck, O. D.
Steam Engines
Gas Mask Eye Lenses
T.N.T. Cylindrical
Trench Fans
Flashlights
Fuses
Fuse Dust
Generator Sets
Expansion Joints
Electric Knives
Metal Forming Machines
Machine Check Writers
Motors
Cannister Nozzles
Oil for Break Switches
Loom Oil
Lard Oil
Quenching and Tempering Oil
Pipe Fittings
Nipples
Malleable Pipe
Sewer Ppie
Signal Plugs
Galvanized Bit Plugs
Steel Springs
Switch Boards
Rubber Tape
Cannister Tops
Tripods for Heliographs
Wrist Watches
Barbed Wire
Plain Copper Wire
Weaving Wire
Differential Cap Pulleys
Resonators
Heavy Wire Screens
English Screws
Shanks for Indicator Posts
Steel
Bar Steel
Structural Steel
Wrought Iron
Angle Posts
Screw Posts
Galvanized Rods
Crucible Tool Steel
Steel Hoops
Strip Steel
Tool Steel
Air Tanks
Galvanized Iron Tanks
Vertical Tubular Boilers
Beaded Edge Casings
Zincographic Chests
Chief Operator's Desks
Motor Fuses
Meat Grinders
Knife Grinding Machines
Gum Box Board
Hob Nails
Engine Lathes
Motors for Grinders
B. T. Boilers
Cavalry Plastrons
Boiling Plates
Screw Plates
Stocks and Dies
Coupling Poles
Payout Reels
Relay Racks
Hand Rip Saws
Spare Parts for Steam Engines
Buffalo Shears
Flagstaffs
Tanks, Wood
Film Tanks
Storage Tanks
Boilers and Covers
Cold Rolled Steel
Oil Reclamation Plants
Wire Firing Reels
Anti-Dimming Outfits
Very Pistol Shells
Bicarbonate of Sodium
Sulphur
Rubber Outlet Valves
Expanded Metal Sheets
Cement Glue
Litharge
Respirators, Horse
Warning Signals, Gas
Trench Sprayers
Rubber Tubing
Wire Outlet Valves
Horseshoe Nails

Surplus Property Branch

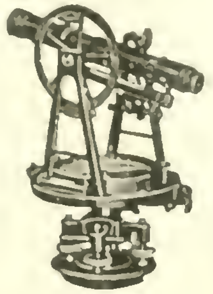
Office of the Quartermaster General War Department
Munitions Building, Washington, D. C.

WAR DEPARTMENT

"Surplus Property Sales"



No. F. 1384, 5⅝-in. Compass Drawing Set as Illustrated
By Mail $7.50
Write for description of other sets
Drawing Materials and Surveying Instruments
KOLESCH & CO., 138 Fulton St., New York
Established 1885.



The Best is Cheapest

Beckmann Transits and Levels, nationally recognized as the best for 46 years, give you the most value for your money. You can buy instruments for less, but you cannot buy equal *service* for as little.

Ask for latest catalog.

The L. Beckmann Co.
200 Jackson St. Toledo, Ohio

WICKES BLUE PRINT SYSTEM

USE THE WICKES SYSTEM

It is Consistently Relinble in Accuracy, Distinctness and Clearness

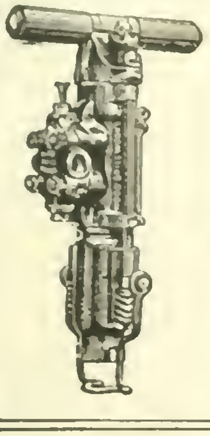
The WICKES blue print system [illegible] that do not fade [illegible] that are [illegible] and distinct. Besides the WICKES Machine is less costly and less liable to break down than the ordinary systems.

Some Reasons Why It Gives Dead White On A Dark Blue Background

1 — Absolutely perfect contact between the tracing and the paper
2 — Mercury vapor light — having practically all its energy given out in actinic rays
3 — Tension in belt regulated automatically
4 — Light projected in a direct radial line through tracing *without passing through intervening glass*
5.— Light closer to the printing paper than in any other type of machine.

A request brings full details.

1856 WICKES BROTHERS 1920
300 Water Street, Saginaw, Mich., U. S. A.



DRILLS

That Stand The Test And Are Employed On The Big Jobs Are Made By The

WOOD DRILL WORKS
Paterson, N. J.

Hammer Drills and Piston Drills

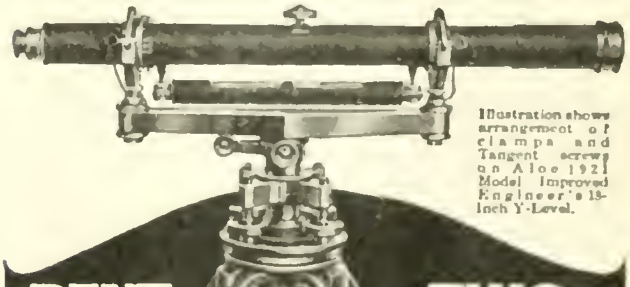


Illustration shows arrangement of clamps and Tangent screws on Aloe 1921 Model Improved Engineer's 18-inch Y-Level.

RENT THIS ALOE "Y" LEVEL
11 MONTHS-THEN ITS YOURS

Here's your chance! Why trust your work and reputation to a borrowed or a dealer's "rent" instrument? Why pay out your money for a borrowed, untrustworthy instrument when you can get the finest on earth on terms so easy you will never miss the money? Take advantage of our wonderful easy rental-purchase plan. Save money while you gain reputation and prestige.

10 Days' Free Trial

We will gladly send you this 18-inch Y-Level, latest 1921 Model, on ten days' free trial. You can take it out on the job and convince yourself it is absolutely accurate and a splendid value at our low price. But if for any reason you do not wish to keep it you can return it to us at our expense and get a refund of your small payment without a question.

Mail Coupon Today

Let us send you full particulars of the Aloe Engineer's Y-Level and details of our selling plan. Learn how you can own your instrument and make it pay for itself and it really costs you nothing. Don't delay— mail the coupon or write us a post card NOW.

A. S. ALOE COMPANY
614 Olive Street
Saint Louis, Mo.

614
A. S.
ALOE CO.
St. Louis, Mo
Send me full particulars about your Y-Level and Easy Rental-Purchase Plan.

Name ....
Address...
....

KARDONG BAR BENDERS

Our Giant Bar Bender is the only hand bender on the market that bends right and left, saving the time and labor of reversing bars. It is guaranteed to bend any type of reinforcing bar up to one and one-half inches in diameter. The machine is built very substantial making it almost indestructible.

The Kardong Power Bar Bender

enables the owner to bend reinforcing bars up to one and one-half inch round, square or deformed. It is equipped with a patented gauge which gives an [illegible] the distance between bends. It also bends right and left. It is equipped with an attachment for bending bars for radius work.

Write for prices and catalogue giving complete information of our line of bar benders.

KARDONG BROTHERS, Minneapolis, Minn., U. S. A.

THE LAST WORD IN BAR BENDERS

For that County Bridge use

BRIDGE ROCKERS

and Steel Plates

made by people who manufacture on a large scale, and carry stock in all sizes of the Illinois Standard Specifications. We also furnish special Rockers of all kinds. Bronze name plates made to order promptly.

Full information on request.

EGYPTIAN IRON WORKS
MURPHYSBORO, ILL.

When a Reinforcing Bar Needs To Be Bent

It needs to be bent then, on the spot, any angle, no slipping or creeping — bent the way wanted.

Contractors can't afford to be without

The Waterloo Bar Bending Machine

It's made in 2 sizes, and is guaranteed to bend bars as follows: No. 2 bends cold reinforcing bars including 1⅛ in. round or square. Price $30.00. No. 3 bends cold reinforcing bars including 1¼-in. round or square. Price $35.00.

Bends bars to various angles desired. Has a detachable handle 7 feet long for convenience in handling.

Waterloo Construction Co., Waterloo, Iowa

NYE New Model High-Pressure Pump

SIMPLE, DURABLE AND RELIABLE
THE MOST COMPACT PUMP MADE

WITHOUT a peer in the handling of both liquids and solids, the Nye Steam Pump works equally well suspended or set on stand. It has a higher vacuum and will deliver more solids at a higher elevation than any other pump on the market.

We wish it distinctly understood that we expect it to stand on its own merits.

HAVE YOU OUR LATEST CATALOG?

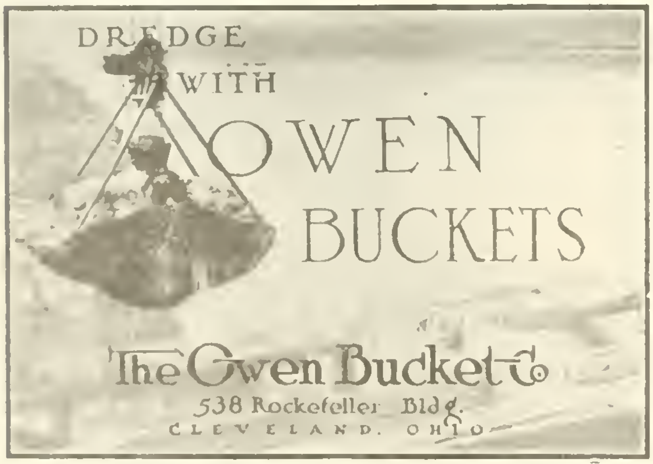
NYE STEAM PUMP & MACHINERY CO.
711 No. Western Avenue CHICAGO, ILL.

"The Pump Without a Peer"

THE FIRST CAST IRON PIPE EVER MADE IN THE WORLDS HISTORY IS STILL IN SERVICE
SERVICE
CAST IRON PIPE
MEASURED BY
CAST IRON PIPE
CENTURIES
MORE THAN 250 YEARS OLD

The Cast Iron Pipe Publicity Bureau

1 Broadway - - New York



Concrete Roads must be reinforced

It is demonstrated beyond doubt that to make concrete roads proof against heavy motor traffic, weather and time, a fabric of steel must be incorporated in the concrete.

Several great states have so ruled.

American Steel & Wire Company's Concrete Reinforcement

fulfills every engineering requirement.

Send for our book on road building.

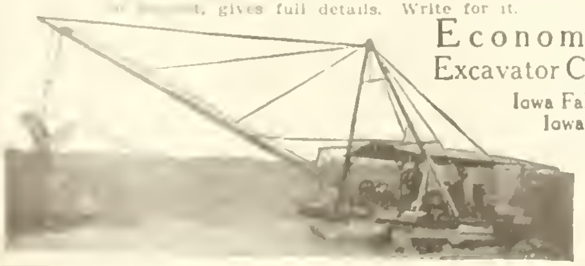
Chicago New York Cleveland Pittsburgh Denver

THE ECONOMY EXCAVATOR

[illegible] to its [illegible] wide operating range, easy portability, and one-man operation the Economy Excavator is the most [illegible] machine for all kinds of trench and ditch excavation. Low cost of working, transporting and erecting enable the Economy to show a profit on small jobs where a heavier, [illegible] machine could not even be considered.

Our complete catalogue, which will be sent on request, gives full details. Write for it.

Economy Excavator Co.
Iowa Falls, Iowa



If you can't find the equipment you are seeking after an examination of our Advertising and Clearing House pages, write us regarding your wants and we will direct you to the concerns that can supply you.

What the Clyde Valve Motion Means to You

1. Flanged spool rigidly held in place [illegible] by adjusting nuts, [illegible] the valve from motion to [illegible] without binding [illegible]
2. Lock nuts.
3. No [illegible] except in steam chest where [illegible]
4. [illegible]
5. [illegible]

FOR years Clyde Steam Hoists have been used by contractors on the big [illegible] jobs, such as dams, bridges, [illegible] and [illegible] construction [illegible]. It is on the performance record of these hoists all over the world that the Clyde claims for superiority are based. The Clyde name is your guarantee.

Correct design, proper materials and the most careful workmanship are the fundamental reasons for Clyde [illegible] reputation.

On a steam hoist these three elements are most essential in the valve motion, and it is here that the real worth [illegible] shown. You will find these properly balanced in the Clyde Steam Hoists. The Clyde Valve Motion [illegible] performance.

Note the Features Listed Above

CLYDE IRON WORKS SALES CO.

DULUTH, MINN., U. S. A.

Sole Distributors for Clyde Iron Works

BRANCH OFFICES AND WAREHOUSES

NEW YORK
[illegible] Centre Street
CHICAGO
1 So. La Salle Street

NEW ORLEANS
[illegible] Magazine Street
JACKSONVILLE
[illegible] Building

SEATTLE
[illegible] First Avenue South
PORTLAND
[illegible] and Upshur Street

ATLAS Storage Battery Locomotives

Require no [illegible] or live wire [illegible] and no [illegible] and no licensed engineer—these are advantages of the ATLAS Storage Battery Locomotives for industrial use.

Atlas Locomotives have many advantages. Removable battery trays, accessible but fully protected parts, all spur gear type drive that eliminates the injurious Cantilever effect, extremely rugged construction, simple and easy to operate, economical and highly efficient.

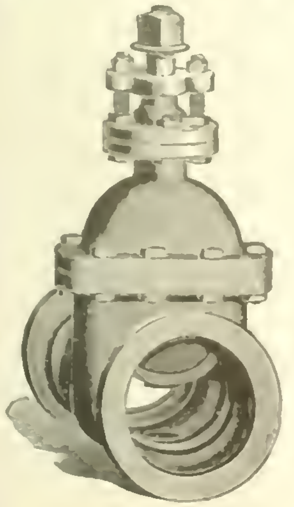
The Atlas Storage Battery Locomotive is in every sense of the word "ALL THAT A GOOD LOCOMOTIVE SHOULD BE."

THE ATLAS CAR AND MFG. CO.

ENGINEERS Cleveland, Ohio. MANUFACTURERS

Fire Hydrants,

Gate Valves and Indicator Posts



For three-quarters of a century Bourbon Fire Hydrants and Waterworks Supplies have enjoyed a leading position in the American Waterworks field.

Bourbon Fire Hydrants, Gate Valves and Indicators are in use in the leading towns and cities of the country, through the choice of the Waterworks authorities in charge.

Write for full information and prices.

The Bourbon Copper and Brass Works Co.
618-620 E. Front St. CINCINNATI, O.
Established 1846

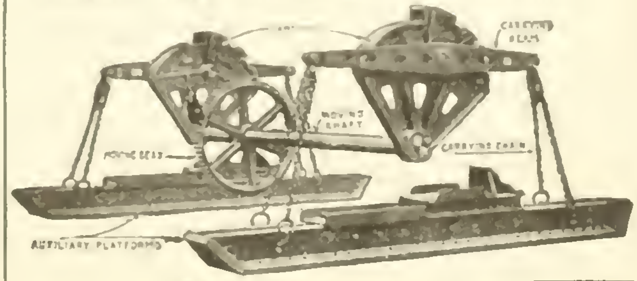
THE MONIGHAN WALKING DEVICE INCREASES YARDAGE

[illegible]

[illegible]

MONIGHAN MACHINE COMPANY
2026 Carroll Avenue, Chicago

[illegible] Walking Device [illegible] and strength.



Rates, $1.00
an inch,
single column

CALLS FOR BIDS

Copy received
until
Monday noon

Bids received until Jan 5 1921

CONSTRUCTION OF STORM RELIEF TRUNK SEWERS AND LATERAL RELIEF SEWERS.

Lima, Ohio.

Sealed proposals for the construction of Relief Trunk Sewers, Contracts No 3 and 4, also the construction of Lateral Relief Sewers, Contracts No. 5, 6 and 7, will be received at the office of the Director of Public Service, Lima Ohio, until 12 o'clock noon, Central Standard Time, January 5th, 1921, and will then be publicly opened and read The City reserves thirty (30) days thereafter in which to act on the bids

The work included under these contracts consists of construction, with all appurtenances, or Relief Trunk Sewers and Lateral Relief Sewers, as above mentioned; a general summary of quantities follows:

Contract No. 3

Total length of sewer about 6,400 lineal feet, varying in size from 27 to 60 inches, all of circular section.

Contract No. 4.

Total length of sewer about 6,430 lineal feet, varying in size from 12 to 30 inches, all of circular section

Contract No. 5.

Total length of sewer about 8,425 lineal feet, varying in size from 12 to 48 inches, all of circular section.

Contract No. 6.

Total length of sewer about 2,540 lineal feet, varying in size from 12 to 24 inches, all circular in section.

Contract No. 7.

Total length of sewer about 4,720 lineal feet, varying in size from 18 to 30 inches, all circular in section, together with all necessary appurtenances, special structurea and manholes.

Copy of plans, form of proposal, contract, bond and specifications may be inspected at any of the following offices: Director of Public Service, City Hall, Lima, Ohio; Fuller & McClintock, Valentine Building, Toledo, Ohio; Fuller & McClintock, 170 Broadway, New York City; B. F. Darling, Supervising Engineer, City Hall, Lima, Ohio

Copies of plans and specifications with form of proposal, contract and bond, may be obtained at the office of the Supervising Engineer, City Hall, Lima, Ohio. The following charge will be made for each set of plans and specifications:

Contract No. 3—Nine Dollars ($9.00)
Contract No. 4—Seven Dollars ($7.00)
Contract No. 5—Seven and 50/100 Dollars ($7.50).
Contract No. 6—Six Dollars ($6.00)
Contract No. 7—Seven Dollars ($7.00)

No charge will be made for proposal [illegible]

The Director of Public Service reserves the right to reject any or all bids, to waive any informalities in the bids received and to accept any bid which is deemed most favorable to the interest of the City of Lima, Ohio

ELMER McCLAIN,
Director of Public Service
B. F. DARLING,
Supervising Engineer

Dated December [illegible]

Bids Received until Jan. 5, 1921.

NOTICE OF LETTING OF DITCH CONTRACT.

New Madrid, Mo.

At the direction of the County Court of New Madrid County, in the State of Missouri, notice is hereby given by the undersigned Clerk of said Court, that the Engineer of Drainage District Number 12 of said County will at the front door of the Court House in the City of New Madrid on Wednesday, the 5th day of January, 1921, let at public auction, to the lowest responsible bidder or bidders, the contract for the construction of certain drains, ditches and water courses in said district, viz.:

Little Otter Slough Ditch, beginning in Sec. 32, T. 26, R. 13, near the St. Louis, Iron Mountain & Southern R. R., and extending in a southeasterly direction to the intersection with Big Otter Slough Ditch near the south line of Sec. 3, T. 34, R. 13, be re-dug for its entire length to a depth shown on profile thereof, filed with report of viewers, with a bottom width as follows: From Sta. O plus 60 to Sta. 211, 14 ft.; from Sta. 211 to Sta. 300, 20 ft.; from Sta. 300 to Sta. 350, 25 ft.; from Sta. 350 to Sta. 451 plus 75, 30 ft; side slopes 1 ft. horizontal to 1 ft. vertical; excavating 179,768.2 cubic yards and clearing 85.43 acres of right of way. Also 1 steel bridge.

Ditch along the south line of St. Louis, Iron Mountain & Southern R. R. from the County line to its junction with Little Otter Slough Ditch re-dug for its entire length to a depth shown on the profile thereof, with bottom width of 8 ft. throughout, excavating 12,102.3 cu. yds.

Main Ditch from Sta. O on Matthews and Canalou Road to Sta. 433 plus 60, or junction of Little River, re-dug to a depth shown on profile thereof, with bottom width as follows: From Sta. O to Sta. 51, 30 ft.; from Sta. 51 to Sta. 433 plus 60, 45 ft.; side slopes 1 to 1; excavating 452,060.8 cu. yds. and 160.15 acres right of way clearing.

Little River beginning at a point 1,000 ft. above the junction of Otter Slough Ditch to Sta. 618 plus 20, or St. Louis Southwestern R. R., re-dug to a depth shown on profile thereof, with bottom width of 50 ft. throughout and side slopes of 1 to 1, excavating 102,388.5 cu. yds. and 69.92 acres right-of-way clearing.

All work to be commenced within six months, completed within two years, and to be performed according to the locations and specifications contained in the report of viewers and engineer, on file in the office of the undersigned County Clerk.

Before any bid will be entertained by the Engineer the prospective bidder must deposit with the Treasurer of said County of New Madrid $1,000.00 or certified check for said sum, as a guarantee that the bidder, if successful, will enter into written contract, to execute bond in at least 20% of the amount of tho bid, for the faithful performance of the work let to him, within the time and in the manner fixed in the contract.

The right is reserved to reject any and all bids.

Contract and bond subject to the approval of the County Court of New Madrid County, Missouri.

Work will be inspected and completed portions paid monthly.

Given under my hand and the seal of said County Court this 7th day of December, 1920.

C. L. V. JONES.
County Clerk.

GRAVELING FEDERAL AID PROJECT.

Bids Close Jan. 5, 1921.

Austin, Minn.

NOTICE TO CONTRACTORS.—Sealed proposals will be received at the office of the County Auditor of Mower County, Austin, Minnesota, until 2 o'clock P. M., January 5, 1921, for the graveling of Federal Project No. 38, State Road No. 1, and State Aid Job No. 2002, State Road No. 4, which involves the following items:

Federal Aid Project No. 38.

Stripping, 1,500 cu. yds.
Hauling, 0 to ½ mile, 2,844 cu. yds.
Hauling, ½ to 1 mile, 3,175 cu. yds.
Hauling, over mile, 12,977 cu. yds.
Cubic yard miles, 21,294 cu. yds.

Job No. 2002.

Stripping, 1,200 cu. yds.
Hauling, 0 to ½ mile, 1,944 cu. yds.
Hauling, ½ to 1 mile, 2,400 cu. yds.
Hauling, over mile, 5,916 cu. yds.
Cubic yard miles, 4,100 cu. yds.

Plans and specifications may be examined at the office of the County Auditor, Austin, Minnesota, or at the office of the State Highway Department, 920 Guardian Life Building, St. Paul, Minn. Blue prints of plans may be obtained from the State Highway Department at bidder's expense. The right is reserved to reject any or all bids and to waive any defects. Bids must be accompanied by a certified check, payable to the County Treasurer, for at least 5 per cent of the amount of the proposal.

(Signed) O. J. SIMMONS,
County Auditor,
Mower County.

U. S. ENGINEER OFFICE, 2nd District, Cincinnati, O., Dec. 21, 1921.—SEALED PROPOSALS will be received here until 10 A. M. (Central Standard Time), Jan. 20, 1921, and then opened, for constructing or fabricating ready for constructing, steel hull for snag boat "Kentucky." Further information on application. W. P. Stokey, Lt. Col., Engrs.

U. S. ENGINEER OFFICE, WHEELING, W. VA.—Sealed proposals will be received here until 11 a. m. (Eastern time), January 22, 1921, and then opened, for furnishing and delivering forged steel and cast iron wheels for gates and structural steel for gate tracks for Dam No. 11, Ohio River. Information on application

---

U. S. Engineer Office, Galveston, Texas. —Sealed proposals will be received here until 12 M., January 20, 1921, and then opened, for dredging Houston Ship Channel, Texas. Further information on application.

PROPOSALS FOR DREDGING—U. S. Engineer Office, 329 Customhouse Bldg., New Orleans—Sealed proposals for dredging in the Intracoastal Waterway between Mermentau and Calcasieu Rivers, La., will be received here until 11 a. m., Jan. 10, 1921. Further information on application.

Rates, $4.00
an inch,
single column

CALLS FOR BIDS

Copy received
until
Monday noon

Bids received until Jan 15, 1[illegible]

NOTICE TO CONTRACTORS

Corning, Iowa.

Notice is hereby given that sealed bids will be received by the County Auditor of Adams County, Iowa, at Corning, Iowa until 1:30 P. M., on the 15th day of January, 1921, for the construction of a drainage ditch and certain laterals in the East Nodaway River Drainage District No. 2.

The work consists of constructing a main ditch, which shall be known and designated as Section 1, with a bottom width of ten and twelve feet, side slopes of one to one, and fifteen feet berms, the approximate length thereof being 6 [illegible] and the approximate quantity in excavation being 512,240 cubic yards, also a lateral ditch known and designated as Section 2, the approximate length of which is 75/100 of a mile and the approximate excavation is 23,040 cu yards, also lateral ditch known and designated as Section No. 3, being 200 feet in length approximately, and the approximate amount of excavation being [illegible] cu yards.

The work shall be commenced not later than March 1, 1921, and to be completed on or before January 1st, 1922.

Copy of the plans and specifications may be seen in the office of the County Auditor of Adams County, Iowa at Corning, Iowa.

Bids will be received and acted upon separately, as to the main ditch and each of the laterals, and said Board at its discretion may let such work, as to the main ditch, as a whole, or as to each lateral as a whole, or by sections, as to both main ditch and laterals, and reserve the right to reject any and all bids and re-advertise the letting of the work.

Each proposal must be accompanied with a certified check made payable to the County Auditor, Adams County, Iowa on some Bank in Corning, Iowa, in an amount not less than ten per cent of the total bid. The successful bidder will be required to execute and furnish a Bond with sureties to be approved by the Auditor of Adams County in an amount equal to 25% of the contract price.

That the work shall be paid for in drainage warrants.

F. W. YEADON
Auditor Adams County, Iowa

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., Dec. 15, 1920.—SEALED PROPOSALS will be received at this office until 3 p. m., Jan 5, 1921 and then opened for new look out gallery, etc. in the United States Post Office, Knoxville, Tenn., in accordance with drawings and specification, copies of which may be had at the office of the Custodian or at this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., Dec. 16, 1920.—SEALED PROPOSALS will be received at this office until 3 p. m., Jan. 10, 1921, and then opened for remodeling the Post Office Screen in the U. S. Post Office, Alliance, Neb., in accordance with the specification and drawings No. 211 and 212, copies of which may be had at this office or at the office of the Custodian, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

[illegible]

STATE HIGHWAY COMMISSION OF MONTANA

Helena, Montana.

SEALED PROPOSALS will be received by the State Highway Commission of Montana for the construction of a steel bridge of [illegible] on concrete piers with two 40 [illegible] across the Big Blackfoot River in Missoula County. The following are approximate quantities:

442,800 lbs. Structural Steel
553 cu. yds. Class "B" concrete
184 cu. yds. Class "A" concrete
100 lin. ft. concrete railing
50,000 lbs. reinforcing steel

No Proposal will be considered unless accompanied by an unconditional certified check, or Contractor's bid bond, in an amount equivalent to five per cent (5%) of the total amount of the bid. A corporate Surety Bond will be required for the faithful performance of the contract.

Plans, specifications, forms of contract and bond, proposal blanks and full instructions may be obtained at the office of the Chief Engineer of the State Highway Commission in the Capitol Building at Helena, Montana. Persons desiring plans and specifications will be required to deposit the sum of $10.00 for each set secured, $8.00 of which deposit will be refunded upon the return of said plans and specifications in good condition to the Chief Engineer.

The Executive Committee reserves the right to reject any and all bids and to waive technicalities as may be deemed best for the interest of the State.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., December 17, 1920.—SEALED PROPOSALS will be opened in this office at 3 p. m., January 11, 1921, for remodeling the United State Custom House and Court House building at El Paso, Texas. Drawings and specifications may be obtained from the Custodian of the building or at this office in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

PROPOSALS FOR STERN-WHEEL STEEL STEAMBOAT "LUTHER L. GRIFFITH."—Office Mississippi River Commission, 1st & 2d Districts, Customhouse, Memphis, Tenn.—Sealed proposals will be received here until 11 a. m., Jan 18, 1921 and then opened, for furnishing the stern-wheel steel steamboat "Luther L. Griffith." Further information on application.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., Dec. 11, 1920.—SEALED PROPOSALS will be opened in this office at 3 p. m. Jan. 6, 1921, for furnishing the labor and certain materials required in the construction (except mechanical equipment) with certain materials that will be furnished by the Government, of a frame laundry building for the United States Marine Hospital at New York, N. Y. (Stapleton). Drawings and specifications may be obtained from the Supervising Chief Engineer, Room 731, United States Custom House, New York, N. Y., or at this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

PROPOSALS FOR STEEL DUMP SCOWS—U. S. Engineer Office, Philadelphia, Pa.—Sealed proposals will be received here until 12 o'clock noon, Dec. 31, 1920, and then opened for furnishing and delivering five steel dump scows. Further information on application.

[illegible]

CONCRETE ROAD CONTRACTORS, ATTENTION!

Helena, Ark.

[illegible] pavement [illegible] wide [illegible]. Will sub the [illegible]. Grading [illegible] completed. A good job [illegible]. Write for information.

GEORGE F. WILHELM CO.
Box 619, Helena, Ark.

Bids received until Jan. 18, 1921

Marion, Iowa.

Sealed bids will be received at the office of the County Auditor of Linn County, Marion, Iowa, to 10 o'clock A. M. Jan. 18, 1921, for the construction of tile drainage. Two districts, estimated cost $18,[illegible] and $11,[illegible]. For plans address M. W. [illegible], Engineer, Marion, Iowa.

H. W. CHURCHILL,
County Auditor.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., December 17, 1920.—SEALED PROPOSALS will be received at this office until 3 p. m., January 10, 1921 and then opened, for new mailing vestibule, extending driveway, etc., at the United States Post Office, Grand Rapids, Mich., in accordance with drawings and specification, copies of which may be had at the office of the Custodian or at this office in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., December 8, 1920.—SEALED PROPOSALS will be received at this office until 3 p. m., December 30, 1920, and then opened, for remodeling post office screen at the United States Post Office and Court House, Elmira, N. Y., in accordance with drawing No. MC-115 and this specification, copies of which may be had at the office of the Custodian or at this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

TREASURY DEPARTMENT, Supervising Architect's Office, Washington, D. C., December 16, 1920.—Sealed proposals will be opened in this office at 3 p. m., January 27, 1921, for the construction of the United States Post Office at Santa Fe, N. Mex. Drawings and specification may be obtained from the custodian of the site at Santa Fe, N. Mex., or at this office, in the discretion of the Supervising Architect. Jas. A. Wetmore, Acting Supervising Architect.

PROPOSALS FOR BOILERS.—Office of the Secretary, Mississippi River Commission, 1311 International Life Bldg., St. Louis, Mo.—Sealed proposals will be received here until 12 noon, Jan. 17, 1921, for furnishing six return-flue boilers for steamboat. Further information on application.

If you don't need it—sell it to the man who does. An advertisement in the CLEARING HOUSE Section will make the sale.

SECOND-HAND MACHINERY **CLEARING HOUSE** BARGAINS IN EQUIPMENT

POSITIONS VACANT

DRAFTSMEN — Structural steel detailers [illegible]. Technical graduates with [illegible] experience preferred. Opportunity for [illegible] higher up for energetic [illegible] experience and salary [illegible] letter. Location, Milwaukee, Wis. Address Box [illegible], care Engineering and Contracting, Chicago, Ill.

WANTED [illegible] tunnel foreman near [illegible], West Virginia, on Virginian Railroad. [illegible] per hour. Apply to Mr. [illegible] T. [illegible] or address us at [illegible], W. Va. W. W. Boxley & Co.

POSITIONS WANTED

REGISTERED STRUCTURAL ENGINEER, M. W. S. E., open for position, contracting or office engineer, expert designer, concrete and structural, buildings, structures and bridges. Salary around $3,600.00. Address Box 1196, care Engineering & Contracting, Chicago, Ill.

MISCELLANEOUS WANTS

TO SUBLET.

[illegible] yard of dirt, [illegible] dredge. [illegible] Mo. Cash payments. [illegible] St. Joseph, Mo.

TECHNICAL POSITIONS

For more than twenty-seven years we have been securing positions for reliable technical men—Engineers, Designers, Estimators, Draftsmen, etc. Particulars of our service furnished free, no advance fee of any kind.

THE ENGINEERING AGENCY, INC.
1662 Monadnock Bldg., Chicago, Ill.

FOR SALE

One ¾ yard Browning Revolving Steam Shovel, used 90 days.
24—1½ yard Western Dump Cars.
Also 27 ton. 20 lb. rail, bolts, spikes and splices.
FRENZEL BROS., 3015 N. California Ave., Chicago
Phone Monticello 2611

Marine Engine Wanted

[illegible] CASH a TRIPLE EX- [illegible] MARINE ENGINE [illegible] 1000 HP at 200 RPM. [illegible] 180 lbs. Address:
Box 1216, Engineering & Contracting
Chicago, Ill.

The Curtiss-Willis Co., Inc.

No. 30 Church St., New York
Largest Exclusive Dealers in
USED and NEW
TANKS
We make lower prices

999 New and Used

Surveying & Scientific Instruments
Rented, Bought, Sold & Exchanged
Architects & Engineers' Supply Co.
913 Grand Ave., Kansas City, Mo.

Prompt Shipments

BEST EXTENSIBLE TRENCHING BRACE MADE
KALAMAZOO FDRY. & MACHINE CO. MICHIGAN
808 EAST MAIN ST.

Are You a Technical Graduate?

It may interest you to know, that over 95 per cent of the membership in the Wilson Engineering Courses is made up of men who have graduated from the best known technical colleges, and in the majority of cases they have had the advantage of more or less practical experience in engineering work.

If you have not enjoyed the advantages mentioned and if you have a good working knowledge of Arithmetic, some Algebra, Geometry and Trigonometry (these are necessary requirements) write us, check the subject in which you are interested, write your name and address on this page, tear it out and send it to us.

Courses of Engineering:

(1)—Structural Drafting.
(2) Structural Steel Designing.
(3) Reinforced Concrete Building Design.
(4) Reinforced Concrete; Miscellaneous Structures.
(5) Reinforced Concrete Engineering, consisting of both (3) and (4).
(6) Structural Engineering, consisting of (2) and (6).
(7) Concrete Drafting and Estimating.

Wilson Engineering Corporation
HANOVER, MASS.

ENGINEERING AND CONTRACTING

is the logical paper for

Proposal Advertising

as it is read each week by a large percentage of the active, responsible contractors. The men who are looking for contracts never fail to read carefully the "Calls for Bids" and the "Contract News" pages.

Proposal Advertising—Increased Bidding

SECOND-HAND MACHINERY CLEARING HOUSE [illegible]

LOCOMOTIVES

Both Narrow and Standard Gauge
Completely Rebuilt

STEAM SHOVELS

- 1—Model 80-C Bucyrus, 4 yard dipper
- 3—Model 60, Marion
- 3—Atlantic type, 2½ yard dipper
- 1—Bucyrus 45, 2 yard dipper
- 1—Model 70-C, Bucyrus
- 1—Marion, Model 20

Also Dump Cars of various types and capacities.

All in stock in Atlanta, Ga.

SOUTHERN IRON & EQUIPMENT CO.
ATLANTA, GA.
Established 1889 Incorporated 1906
Main Office and Plant, ATLANTA, GA.
Branch Office, New Orleans, La.

CONTRACTORS' EQUIPMENT

U. S. Army and Navy Salvage Goods

Pyramid Government Tents, slightly used, made of 12 oz Khaki canvas 1 ft wall, size 16 ft. x 16 ft., $25

Pup Tents—Used in good condition, suitable to cover sewer pipe work, $2.50

Blankets—U. S. Marine Corps, reclaimed 3 lb weight, excellent condition, $4.50 Worth double

Hip Rubber Boots, new, $4.25, salvage, $3.85

Bunks, upper and lower sleeping bunks, made of Black Angle Iron, National Spring and Helicals, size 2 ft. 6 inches, $5

Bunks—upper and lower sleeping bunks, made of continuous posts, white enamel, size 3 ft., $6

Heavy Work Shoes—10,000 pairs tan all leather work shoes, U. S. Army style, Munson last, sizes, 6 to 11, 7 to 12, price, $3.25 a pair.

Pea Jacket—rare opportunity for men doing outdoor work, $12.50 each

Also general line of merchandise suitable for contractors camps, such as raincoats wool and cotton underwear, sweaters, gloves, etc.

The above is surplus U. S. Army equipment.

MERCHANTS' CLEARING HOUSE OF AMERICA
557 Broadway, NEW YORK CITY

'Phone Spring 3143 or send Special Delivery Letter

FOR PROMPT SHIPMENT

- 1—8¼x10 3-Drum Lidgerwood Skeleton Hoist
- 1—7x12 D. D., D. C., Mundy Hoist and Boiler
- 1—Holding Drum
- 1—10-ton Kelly Steam Roller
- 1—10-ton Huber D. C., Steam Roller with Scarifier
- 1—No. 10 Galion Engine Grader
- 2—15-ton Galion Stone Unloaders
- 1—No. 11 Koehring Steam Paver
- 2—No. 30 Smith-Chicago Mixers
- 1—¾-yd. Smith Mixer, all on Skids Side Loader, Steam Engine only Can furnish Boilers
- 1—Buckeye Steam Trench Machine, Capacity 15" wide 5'6" deep
- 1—10x20 Case Jaw Crusher with Elevator
- 1—¾ yd Hayward Orange Peel Bucket
- 12—1-yd. 24" Gauge Koppel Cars
- 2—No. 2 Vulcan Steam Pile Hammers
- 1—Haiss Wagon Loader, Motor Drive

The T. J. Lane Equipment Company
1030 West Main Street Springfield Ohio

ATTENTION!!!

FOR SALE

NEW and RELAYING RAILS

For Foundations and Reinforcing. All weights and cut to any length.

HYMAN-MICHAELS CO.
Peoples Gas Building
Phone, Harrison 1100
CHICAGO

FOR SALE

[illegible]

G. D. McKisson - Fairmont, Minnesota

What Have You?

If you have just finished a contract and have any used machinery to sell, list it in the "Clearing House."

If you don't need it—sell it to the man who does. An advertisement in the CLEARING HOUSE section will make the sale.

SECOND-HAND MACHINERY CLEARING HOUSE BARGAINS IN EQUIPMENT

FOR SALE OR RENT

We specialize in the rental of all classes of construction equipment, especially steam shovel outfits. We have a large stock of thoroughly repaired equipment always on hand, either for rent or for sale. The following is a partial list:

STEAM SHOVELS

2—Marion 60 Steam Shovels, 2½-yd. dipper Shop Nos. 1999, 2059.
1—70-C Bucyrus, shop No. 1219.
1—Model 60 Marion, shop No. 2130.
1—Model 1 Thew, on railroad trucks, ⅞ yard dipper.

CONCRETE MIXERS

1—13-E Foote Paver, with 9 H. P. gasoline engine, mounted on traction wheels, with 18' distributing chute.
1—No. 11 Cube Mixer, mounted on traction wheels, with steam engine and boiler, equipped with boom and bucket, also gravity chute.

LOCOMOTIVES

8—10x16" H. K. Porter 36" gauge Dinkeys.
2—9x14" H. K. Porter 36" gauge Dinkeys.
1—17x24", 55-ton, 4-6-0, standard gauge.
3—25-ton Forney type.

MISCELLANEOUS

1—Worthington 12x17x10x15 Steam Pump, for 140 lbs. water pressure.
1—10", 3-stage Centrifugal Pump, direct connected to Moore steam turbine, 3000 gal. at 375' head.
1—14x7x12 Underwriter's Pump (Knowles).
1—10" Sand Pump, connected to 9½x9½ double cylinder engine.

Send for Our Complete List

Eastern Office: 30 Church St., New York.

H KLEINHANS Co
PITTSBURG, PA.

To Bring a Definite Message to Men in Any Line of Business, Choose a Medium Published PRIMARILY in the Interests of and Circulating Among Men Engaged in That Particular Line of Business.

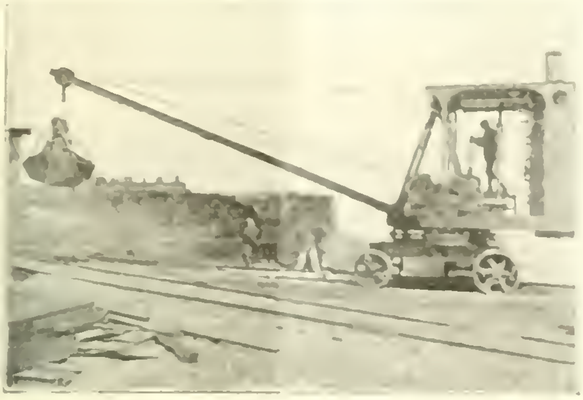
If you have equipment to offer contractors the CLEARING HOUSE section of ENGINEERING and CONTRACTING with a circulation of more than 10,000 is the most direct and economical medium in which to advertise.

One CLEARING HOUSE advertiser writes as follows: "Referring to the adv. which we requested that you insert four times in your publication we are now writing to ask that you discontinue the insertion of this adv. as we are nearly swamped with replies."

Maximum rate $3.50 per inch. Minimum rate $1.75 per inch.

SEND IN YOUR COPY TO-DAY FOR THE NEXT ISSUE

SECOND-HAND MACHINERY CLEARING HOUSE



LOCOMOTIVE CRANES

Full Revolving Self-Propelling

Mounted on Traction Road Wheels
Equipped with 30 ft. Boom and
¾ yd. Clamshell Bucket

ALL BRAND NEW

1—Iroquois 800 yd. Road Asphalt Plant in two units
1—Twelve ton 24-inch gauge Climax Geared Locomotive

ROAD BUILDING EQUIPMENT

1—Good Roads Mch. Co. 10 ton Tandem Steam Road Roller
1—Monarch 10 Ton 3-wheel Steam Road Roller

F. MAYER, 737-738 Monadnock Building, Chicago

FOR SALE

1—Ransome Mixer on Skids, with Batch Hopper, Steam Engine only, capacity of mixed concrete 10 cu. ft. This machine is practically new

1—5-A used Foote Road Wheel Traction Paver.

3—6-A used Foote Road Wheel Traction Pavers, all with spouts and all in good working condition.

Will make special price for entire lot to machinery houses. These machines are all for immediate delivery and at bargain prices.

C. C. DAWSON
613 Republic Bldg. Kansas City, Mo.

McMYLER LOCOMOTIVE CRANE

20-ton, 8-wheel, M. C. B., 50′ boom, D. D., first class.

Moore Bros.
MACHINERY
39 So. La Salle St. Chicago, Ill.

STEEL SHEET PILING FOR SALE

48[illegible] tons 14 inch, 40.8 pound per foot, Lackawanna arch web steel sheet piling, four corner piles included. Length 25 ft.

48[illegible] tons 14 inch, 40.8 pound per foot, Lackawanna arch web steel sheet piling, four corner piles included. Length 32 ft.

All in first class condition and ready for immediate shipment from point in Mississippi. For particulars address

GOULD CONTRACTING CO.,
Nashville, Tenn

FOR SALE

1 Marion 1 yd. Floating Dredge. Steam. Can be easily changed to gasoline or kerosene power. Minnesota or Wisconsin delivery. Address Box [illegible], care of Engineering and Contracting, 608 S. Dearborn St., Chicago Ill.

FOR SALE

Parsons trench machine, large size, and repairs. Will sell cheap if taken at once. Address Box 3024, care Engineering and Contracting, 608 So. Dearborn St., Chicago, Ill.

STEEL PILING

Want large quantity, varying in length from 16 to 45 ft., for dam construction. Address Box 1214, care Engineering and Contracting, Chicago, Illinois.

It Pays to Watch the Clearing House :: Use It To Sell Your Second-hand Equipment

DIRECTORY OF CIVIL ENGINEERS

Alvord & Burdick

[illegible] B. Burdick

Hydraulic and Sanitary Engineers

[illegible] Water Purification, [illegible] Relief, Sewerage, [illegible] Disposal, Appraisals [illegible] Reports [illegible] Power.

[illegible] Hartford Building

Arnold Co., The

Engineers—Constructors

Electrical—Civil—Mechanical

[illegible] Plans and [illegible] covering complete properties. Construction of complete properties [illegible] preliminary operation [illegible] plant

[illegible] So. LaSalle St.

Black & Veatch

Consulting Engineers

[illegible] Sewage Disposal, Water Supply, Water Purification, Electric Lighting, Power Plants, Valuations, [illegible] Investigations and Reports.

E. B. Black N. T. Veatch, Jr. Kansas City, Mo., Interstate Building.

Blanchard, Arthur H.

M. Am. Soc. C. E., M. E. Inst. Can. Consulting Highway Engineer

[illegible] Transportation Surveys, Reports, Specifications, Estimates, Litigation Cases.

Ann Arbor Michigan

Chicago Paving Laboratory

L. Kirschbraun
H. W. Skidmore

Consulting and Inspecting Engineers — Pavements and Paving Materials

Consultation, design, specifications, reports, testing, inspection and research.

[illegible] St., Chicago.

Fargo Engineering Co.

Consulting Engineers

[illegible] Michigan

HYDRO-ELECTRIC AND STEAM POWER PLANTS [illegible]

[illegible] Whipple & Fuller

[illegible]

Consulting Hydraulic and Sanitary Engineers

[illegible]

This Directory reaches the officials with whom rests the responsibility for the bulk of the municipal, state, government and industrial engineering works in the United States. It offers you a dignified and ethical means of cultivating a wider acquaintance among prospective clients.

RATE—$1.25 per inch per issue or $50.00 per year paid in advance.

Hubbell, Clarence W.

M. Am. Soc. C. E.

Consulting Engineer

Sewerage, Sewage Disposal, Water Supply and Municipal Engineering.

Detroit, Mich., 2348 Penobscot Building.

Hunt, Robert W., & Co

Robert W. Hunt,
Jno. J. Cone,
Jas. C. Hallsted
D. W. McNaugher.

Engineers, Inspectors, Metallurgists, Chemists.

Resident Inspectors at Manufacturing Plants.

Chemical, Physical, Cement Laboratories.

Chicago, New York, Pittsburgh, San Francisco, Montreal, London.

Jacobs & Company, J.L.

Industrial and Municipal Engineers

Investigations — Reports — Plans covering Organization, Management Accounting and Cost Methods, Employment and Wage Problems, Appraisals — Expert Testimony.

Chicago, Monadnock Building.

Maury, Dabney H.,

Consulting Engineer

Water Works Sewerage.
Power Plants. Appraisals

Chicago, Ill., 1445 Monadnock Bldg.

Metcalf & Eddy

Water Works, Sewerage

Disposal of Sewage and Industrial Wastes. Supervision of Operations. Valuations.

Boston, Mass., 14 Beacon St.

Perkins, Edmund T., Engineering Company

Consulting and Supervising Engineers

[illegible]

Pride & Fairley

Consulting Engineers

Specializing in:

Drainage, Flood Prevention, Reports and Investigation.

Joe P. Pride, formerly Chief Engineer, St. Francis Levee District.

O. M. Fairley, formerly Assistant Engineer, Bureau of Drainage Investigation, Department of Agriculture.

W. H. Poe, Hydraulic Engr.

Blytheville, Ark.

Potter, Alexander, C. E.

Hydraulic Engineer and Sanitary Expert

Sewerage and Sewage Disposal, Water Supply and Purification.

New York, 50 Church Street

Rossiter, Edgar A.

Consulting Engineer

Water Supply and Purification, Municipal Engineering Farm Drainage, Sewerage

Room 605, 127 North Dearborn St., Chicago.

Dwight P. Robinson and Company, Inc.

Engineers and Constructors

Consolidated with

Westinghouse, Church, Kerr & Co., Inc.

Industrial Plants
Power Developments
Railroad Shops and Terminals

125 East 46th St., New York
Chicago Cleveland
Pittsburgh Dallas
Youngstown Los Angeles

Smith & Co., C. E.

Consulting Engineers

2065-75 Railway Exchange Bldg., St. Louis.

1313 Steger Bldg., Chicago
204 Live Stock Exchange, Kansas City

Investigations, Reports, Appraisals, Expert Testimony, Bridge and Structural Work, Railway Problems, Electrification, Grade Crossing Elimination, Foundations, Highways, Docks, Water Supply, River and Flood Protection, Drainage and Sanitation, Power Plants, Naval Architecture.

Stone & Webster

Incorporated

Design and Construct

Water Power Developments
Substations
Gas Plants
Steam Power Stations
Transmission Lines

Boston
New York Chicago

Waddell, Dr. J. A. L.

Consulting Engineer

Steel and Reinforced Concrete Structures, Waddell's Vertical Lift Bridge. Difficult Foundations. Reports, Checking of Designs, Advisory Services, and Appraisals.

35 Nassau Street, New York

Wheeler & Bosworth

Estimates Plans
Municipal Public Utilities
Harbor Improvements
Hydro-Electric
Foundations Dams
Engineering & Construction
372 Central Ave. Dover, N. H.

THE J. G. WHITE ENGINEERING CORPORATION

Engineers **Constructors**

Industrial Plants, Buildings, Steam Power Plants, Water Powers, Gas Plants, Steam and Electric Railroads, Transmission Systems.

43 Exchange Place New York

This Directory

is a medium of publicity in accord with professional ethics

You can increase your clientele by placing your card here and the expense is small

ALPHABETICAL INDEX TO ADVERTISERS

Page

A

[illegible]
Allis-Chalmers Mfg. Co. 1[illegible]
[illegible] Co., A. S. 1[illegible]
Am. Cast Iron Pipe Co. 1[illegible]
Am. Cement Mch. Co. 1[illegible]
American Sheet & Tin Plate Co. 1[illegible]
American Spiral Pipe Wks. [illegible]
American Steel & Wire Co. 1[illegible]
American Well Works [illegible]
Asphalt Association [illegible]
Atlas Car & Mfg. Co. 1[illegible]
Austin Mach'y Corpn. [illegible]
Austin-Western Road Machinery Co. [illegible]
Avery Company [illegible]

B

Ball Engine Co. [illegible]
Badger Concrete Mixer Co. [illegible]
Barnes Mfg. Co. [illegible]
Bay City Dredge Works [illegible]
Beckman Co., The L. 11[illegible]
Bellwood Steam Shovel Co., Inc. 1[illegible]
Blaw-Knox Company 8
Bourbon Copper & Brass Co. 11[illegible]
Browning Co., The [illegible]
Brown Hoisting Machinery Co. [illegible]
Buckeye Traction Ditcher Co. [illegible]
Bucyrus Co. [illegible]
Buffalo-Springfield Roller Co. 1[illegible]
Burton Engineering Co. 112
Byers, Jno. F., Machine Co. [illegible]

C

Carey Co., Philip, The [illegible]
Cast Iron Pipe Publicity Bureau 118
Cement-Gun Co. [illegible]
C. H. & E. Mfg. Co., Inc. 62
Chain Belt Co. 61
Chalmers & Williams [illegible]
Chicago Pneumatic Tool Co. 64
Clark Tructractor Co. [illegible]
Cleveland Tractor Co. 69
Clyde Iron Works [illegible]
Conveyors Corpn. of Am. 99
Crane Co. 28-29
Cressey Rd. Sprayer Co. 111
Cropp & Co., B. M. 1[illegible]
Cummer & Son Co., The F. D. 103

D

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

E

[illegible]
Economy Drawing Table Co. [illegible]
[illegible] Excavator Co. 1
[illegible] Mfg. Co. [illegible]
[illegible] Iron Works 1[illegible]
[illegible] Pump & Valve Co. 1[illegible]
Erie Machine Shop 1[illegible]

F

[illegible] Morse & Co. 10[illegible]
Fate-Root-Heath Co. 67
[illegible] Manufacturing Co. 1[illegible]

G

[illegible]
Gifford-Wood Co. 1[illegible]
[illegible] & Co. 130
Great Southern Lumber Co. 94
[illegible] L. P. 1[illegible]
[illegible] Patent Crusher & Pulverizer Co. 41

H

Haggard & Marcusson Co. [illegible]
[illegible] The Geo. [illegible] Mfg. Co. 110
[illegible] Company 7[illegible]
[illegible] Company 18-19

I

Ingersoll-Rand Co. 6
Insley Mfg. Co. Third Cover

J

Jaeger Mch. Co. 81
Jordan Co., O. F. 48
[illegible] Manufacturing Co. [illegible]-21

K

Kardong Bros. 117
Keystone Driller Co. [illegible]
Kinney Mfg. Co. 107
[illegible] & Co. [illegible]
Koppel Indust. Car Co. 1[illegible]

L

[illegible]
[illegible]
[illegible]
[illegible]
[illegible] Mfg. Co. [illegible]
[illegible]
[illegible]
[illegible]

M

[illegible]
[illegible]
[illegible]
[illegible]
Mc[illegible]
Mc[illegible]
McMyler Interstate [illegible]
[illegible] Machine Co. [illegible]
Milwaukee [illegible]

N

[illegible] Water [illegible] Co. 1[illegible]
Newport Culvert Co. [illegible]
Northwestern [illegible] Wks. [illegible]
Nye Steam Pump & Mach. Co. 11[illegible]

O

Ohio Locomotive Crane Co. [illegible]
Orton & Steinbrenner Co. 1[illegible]
Osgood Co., The [illegible]
Owen Bucket Co. 118
Oxweld Acetylene Co. [illegible]

P

Pacific Lumber Co. [illegible]
Pawling & Harnischfeger Co. [illegible]
Pittsburgh Meter Co. [illegible]
Portland Cement Assn. [illegible]
Pierce-Arrow Motor Car Co. [illegible]
Pulsometer Steam Pump Co. Front and Back Covers

R

[illegible]
[illegible] 91
[illegible] 91
[illegible] 1[illegible]

S

[illegible]
[illegible]
[illegible] 1[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible] 10[illegible]

T

[illegible]
[illegible]
[illegible]
[illegible]

U

Universal [illegible] Co. [illegible]

V

[illegible] Works 1[illegible]

W

W[illegible] Co. 130
Waterloo Constr. Co. 118
Webster Mfg. Co. 51
Weller Mfg. Co. 56
Western Wheeled Scraper Co. 2[illegible]-25
Western Wood Pipe Publicity Bureau 10-11
Whitcomb Co., Geo. D. 1[illegible]
White Co., David 130
White Co. Second Cover
W[illegible] Plow Co. 105
Wickes Bros. 117
Williams Co., G. H. 54
Williamsport Wire Rope Co. 58
Wilson Walker Co. 102
Wood Drill Works 117

CLASSIFIED INDEX TO ADVERTISERS

Acetylene Apparatus, Lights, Carbide, Etc.
Prest-o-lite Co., Inc.
Air Compressors.
Allis-Chalmers Mfg. Co.
American Well Works.
Bucyrus Co., The.
Cement Gun Co.
Chicago Pneumatic Tool Co.
Domestic Engine & Pump Co.
General Electric Co.
Ingersoll-Rand Co.
Sullivan Machinery Co.
Air Hose.
Chicago Pneumatic Tool Co.
Air Reheaters, Aftercoolers, Receivers, Etc.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Air Motors.
Chicago Pneumatic Tool Co.
Dake Engine Co.
Ingersoll-Rand Co.
Asphalt Paving.
Asphalt Association.
Barrett Company.
Barber Asphalt Company.
Kentucky Rock Asphalt Co.
Standard Oil Co. (Indiana).
Asphalt Machinery.
Acme Road Mach. Co.
Barber Asphalt Paving Co.
Clark Tructractor Co.
Cummer, F. D., & Sons.
Equitable Asphalt Maintenance Co.
Erie Machine Shop.
Littleford Bros.
Back Fillers—Trench.
Austin, F. C., Mach. Co.
Domestic Eng. & Pump Co.
Parsons Company.
Pawling & Harnischfeger Co.
Weller Mfg. Co.
Ballast Unloaders, Spreaders.
Jordan & Co., The O. F.
Osgood Co., The.
Bar Cutters.
Braun, J. O.
Koehring Machine Co.
Bar Benders.
American Pipe Bending Co.
Kardong Bros.
Waterloo Construction Co.
Bars, Concrete Reinforcing.
Witherow Steel Co.
Bars, Steel.
Witherow Steel Co.
Battery Charging Equipment.
General Electric Co.
Belt Tighteners, Trippers.
Link Belt Co.
Weller Mfg. Co.
Blast Furnaces.
McClintic-Marshall Co.
[illegible] Knox Co.
Blasting Supplies (See Dynamite and Powder).
Blocks—Snatch and Tackle.
Carpenter, Geo. B., & Co.
Dobbie Fdry. & Mach. Co.
Insley Mfg. Co.
Leschen & Sons Rope Co.
Blowers.
General Electric Co.
Ingersoll-Rand Co.
Blue Print Machines.
Wickes Bros.
Blue Print Filing Cases.
Economy Drawing Table Co.
Books.
Lefax (Inc.)
McGraw Hill Book Co.
Trautwine Company
John Wiley & Sons, Inc.
Boiler Breechings.
Honhorst, Jos., The, Co.
Littleford Bros.
[illegible] Iron W[illegible]
Bridges, Roofs, Trusses, Etc.
Blaw-Knox Co.
Caldwell, W. E. Co.
Chicago Bridge & Iron Works.
Kenwood Bridge Co.
McClintic-Marshall Co.
Pittsburgh-Des Moines Steel Co.
Raymond Concrete Pile Co.
Strauss Bascule Bridge Co.
Buckets, Clamshell and Orange Peel, Grab.
Advance Engineering Co.
Blaw Knox Co.
Browning Co., The
Brown Hoisting Mach. Co.
Buffalo Hoist & Derrick Co.
Carpenter, Geo. B., & Co.
Haiss Mfg. Co.
Hayward Co., The
Insley Mfg. Co.
Lakewood Engineering Co.
Link Belt Co.
McMyler Interstate Co.
Mead Morrison Mfg. Co.
Ohio Locomotive Crane Co.
Orton & Steinbrenner Co.
Owen Bucket Company
Pawling & Harnischfeger Co.
Stearns, Jas. B.
T. L. Smith Co.
Williams Co., G. H.
Buckets, Concrete.
Insley Mfg. Co.
Jeffrey Mfg. Co.
Smith Co., T. L.
Weller Mfg. Co.
Bunk—Contractors'.
Haggard & Marcusson.
Southern Rome Co.
Buildings, Industrial.
Blaw Knox Co.
McClintic-Marshall Co.
Truscon Steel Co.
Buildings, Portable Steel.
[illegible] Knox Co.
Bunk Houses, Contractors'.
Carpenter, Geo. B., & Co.
Southern Rome Co.
Cableways—Wire Rope.
[illegible]
S. Flory Mfg. Co.
Leschen & Sons Rope Co.
Lidgerwood Mfg. Co.
Mansfield Engineering Co.
Roebling's Sons, John A.
Sauerman Bros.
Waterbury Company
Cars—Contractors', Industrial.
Atlas Car & Mfg. Co.
Bellwood Steam Shovel Co.
Clark Tructractor Co.
Insley Mfg. Co.
Koppel Industrial Car & Equip. Co.
Kilbourne & Jacobs Mfg. Co.
Lakewood Engineering Co.
T. L. Smith Co.
Weller Mfg. Co.
Western Wheeled Scraper Co.
Car Pullers, Electric.
Mead Morrison Co.
Carts for Concrete, Etc.
Clark Tructractor Co.
Carpenter, Geo. B., & Co.
Insley Mfg. Co.
Kilbourne & Jacobs Mfg. Co.
Smith, The T. L., Co.
Sterling Wheelbarrow Co.
Cement.
Alpha Portland Cement Co.
Sandusky Cement Co.
Cement—Cement Appliances.
Cement Gun Co.
Centers, Sewer Construction.
Blaw Knox Company.
Chains—Dredge, Shovel, and All Types for Elevating, Conveying and Power Transmission Purposes.
Bucyrus Company, The.
Carpenter, Geo. B., & Co.
Jeffrey Mfg. Co.
Channellers.
Ingersoll Rand Co.
Sullivan Machinery Co.
Chimneys.
Chicago Bridge & Iron Co.
General Concrete Const. Co.
Wiederholdt Const. Co.
Chloride of Lime.
Mathieson Alkali Works (Inc.).
Pennsylvania Salt Mfg. Co.
Chlorine and Chlorinators.
Electric Bleaching Gas Co.
Wallace & Tiernan.
Mathieson Alkali Works (Inc.)
Chutes and Elevators—Concrete.
Clark Tructractor Co.
Insley Mfg. Co.
Jaeger Machine Co.
Lakewood Engineering Co.
T. L. Smith Co., The.
Weller Mfg. Co.
Circuit Breakers.
General Electric Co.
Westinghouse Electric & Mfg. Co.
Clamps—Form (See Forms).
Bucyrus Co., The.
Universal Form Clamp Co.

CLASSIFIED INDEX TO ADVERTISERS

- **Coal and Ash Handling Machinery.**
  - Barber Greene Co.
  - Bellwood Steam Shovel Co.
  - Brown Hoisting Mach. Co.
  - Byers Machine Co., John F.
  - Link Belt Co.
  - Clark Tructractor Co.
  - Gifford Wood Co.
  - Haiss, Geo. F., Mfg. Co
  - Jeffrey Mfg. Co.
  - Lidgerwood Mfg. Co.
  - Link Belt Co.
  - McMyler Interstate Crane Co.
  - Portable Machinery Co.
  - Weller Mfg. Co.
- **Coal Tipples.**
  - McClintic-Marshall Co.
- **Columns—Cast Iron, Building.**
  - U. S. Cast Iron Pipe & Fdry. Co.
- **Compressors (See Air Compressors).**
- **Concrete Construction.**
  - General Concrete Const. Co.
- **Concrete Column Clamps.**
  - Concrete Distributing Plant (See Chutes).
- **Concrete Mixers (See Mixers).**
- **Concrete Reinforcing Materials (See Steel Reinfo'g).**
- **Condensers, Low Level Jet, Surface.**
  - Ingersoll-Rand Co.
- **Connectors, Frankel Solderless.**
  - Westinghouse Electric & Mfg. Co.
- **Contractors' Buildings (See Buildings, Industrial).**
- **Control, Electric.**
  - General Electric Co.
  - Westinghouse Electric & Mfg. Co.
- **Conveyors, Belt.**
  - Acme Road Mach. Co.
  - Barber-Greene Co.
  - Gifford-Wood Co.
  - Jeffrey Mfg. Co.
  - Link Belt Co.
  - Mathews Gravity Carrier Co.
  - Portable Machinery Co.
  - Russell Grader Mfg. Co.
  - Webster Mfg. Co.
  - Weller Mfg. Co.
- **Conveyors, Portable.**
  - Barber-Greene Co.
  - Acme Road Mach. Co.
  - Gifford-Wood Co
  - Haiss, Geo. F., Mfg. Co.
  - Jeffrey Mfg. Co.
  - Mathews Gravity Carrier Co.
  - Mead-Morrison Co.
  - Portable Machinery Co.
  - Russell Grader Mfg. Co.
  - Smith Eng. Works.
  - Webster Mfg. Co.
- **Cordage.**
  - Plymouth Cordage Co.
- **Couplings, Air Hose.**
  - Chicago Pneumatic Tool Co.
- **Cranes—Locomotives.**
  - Browning Co., The.
  - Brown Hoisting Mach. Co.
  - Byers, J. F., Machine Co.
  - Jeffrey Mfg. Co.
  - Locomotive Crane Co. of America.
  - Link Belt Co.
  - McMyler Interstate Co.
  - Northwest Engineering Wks
  - Ohio Locomotive Crane Co.
  - Orton & Steinbrenner Co.
  - Severns, Jas. B.
  - Thew Automatic Shovel Co
- **Cranes—Auto.**
  - Byers, The John F., Machine Co.
- **Cranes—Traveling.**
  - Bucyrus Co.
  - Brown Hoisting Mach. Co.
  - Link Belt Co.
  - Pawling & Harnischfeger Co
- **Creosoted Blocks, Piling, Ties.**
  - Barber Asphalt Paving Co.
  - Barrett Company, The
  - Great Southern Lumber Co
  - Republic Creosoting Co.
- **Crushers and Pulverizers.**
  - Acme Road Mach Co.
  - Allis-Chalmers Mfg. Co.
  - Austin Mfg. Co
  - Bellwood Steam Shovel Co
  - Chalmers & Williams
  - Jeffrey Mfg. Co.
  - Orton & Steinbrenner Co
  - Smith & Sons Mfg. Co
  - Smith Engineering Works
  - Universal Road Mach. Co.
  - Weller Mfg. Co
- **Culvert Forms and Molds.**
  - Blaw-Knox Co.
  - Heltzel Steel Form & Iron Co.
  - Interlocking Culvert Co.
  - Storms Mfg. Co.
  - Willite Rd. Const. Co.
- **Culverts.**
  - American Rolling Mill Co.
  - American Sheet & Tin Plate Co.
  - Armco Iron Culvert & Flume Mfrs.
  - Bark River Bridge & Culv. Co.
  - California Corr. Culv. Co.
  - Dixie Culvert & Metal Co
  - Hardesty Mfg. Co., R.
  - Illinois Corrugated Metal Co.
  - Independence Culvert Co.
  - Inland Steel Co.
  - Interlocking Culvert Co.
  - Kentucky Culvert Mfg. Co.
  - Lone Star Culvert Co.
  - Lyle Corr. Culvert Co.
  - Massey Concrete Products Corp.
  - Maryland Cul. & Metal Co.
  - Nebraska Cul. & Mfg. Co.
  - Nevada Metal Mfg. Co.
  - New Eng. Metal Culv. Co.
  - Newport Culvert Co.
  - Ohio Corr. Culvert Co.
  - Penna. Metal Culvert Co.
  - Road Supply & Metal Co.
  - Russell Grader Mfg. Co.
  - Sioux Falls Metal Co.
  - Spokane Culv. & Tank Co.
  - Tenn. Metal Culvert Co.
  - Utah Corrugated Culvert & Flume Co.
  - U. S. Metal Culvert Co.
  - U. S. Cast Iron Pipe & Fdry. Co.
  - Virginia Metal Corp
  - Western Metal Mfg. Co.
  - Whittaker-Glessner Co.
  - Wyatt Metal & Boiler Wks.
- **Curb Boxes (See Meters).**
- **Curb and Gutter Forms.**
  - Blaw-Knox Co.
  - Heltzel Steel Form & Iron Co.
- **Cutting Apparatus.**
  - Oxweld Acetylene Co
- **Data Sheets.**
  - Lefax (Inc.).
- **Derrick and Derrick Fittings.**
  - American Hoist & Derrick Co.
  - Byers, The John F., Machine Co.
  - Buffalo Hoist & Derrick Co.
  - Carpenter, Geo. B., & Co.
  - Clyde Iron Works.
  - Dake Engine Co.
  - Des Moines Bridge & Iron Co.
  - Dobbie Fdry. & Mach. Co.
  - Hayward Co.
  - Insley Mfg. Co.
  - Lidgerwood Mfg. Co.
  - McMyler Interstate Co.
  - Ohio Locomotive Crane Co.
  - Sasgen Derrick Co.
- **Ditching Machinery.**
  - Austin F. C. Mach. Co.
  - Ball Engine Co.
  - Bay City Dredge Works.
  - Bellwood Steam Shovel Co.
  - Browning Co., The.
  - Buckeye Traction Ditcher Co.
  - Bucyrus Company, The.
  - Byers, J. F., Machine Co.
  - McMyler Interstate Co.
  - Monighan Machine Co.
  - Myers-Whaley Co.
  - Parsons Co., The
  - Pawling & Harnischfeger Co.
  - Thew Automatic Shovel Co.
- **Drafting Room Furniture (See also Engineers' Supplies).**
  - Economy Drawing Table Co.
  - Hein Furniture Co.
- **Dragline Scrapers, Excavators and Buckets.**
  - Austin, F. C., Mach. Co.
  - Ball Engine Co.
  - Brown Hoisting Machinery Co.
  - Dobbie Fdry. & Mach. Co.
  - Green L. P.
  - Lidgerwood Mfg. Co.
  - Link Belt Co.
  - Monighan Machine Co.
  - Osgood Co., The.
  - Pawling & Harnischfeger Co
  - Sauerman Bros
- **Dredges & Dredging Machinery.**
  - Austin, F. C., Mach. Co.
  - Bay City Dredge Works.
  - Bucyrus Co., The.
  - Erie Pump & Engine Co.
  - Lidgerwood Mfg. Co.
  - Osgood Co., The.
  - Thew Automatic Shovel Co.
  - Wilson Walker Co., The.
- **Drills—Core.**
  - American Well Works, The.
  - Chicago Pneumatic Tool Co.
  - Ingersoll-Rand Co.
  - Sullivan Machinery Co.
- **Drills, Portable, Air & Electric.**
  - Chicago Pneumatic Tool Co.
- **Drills, Rock.**
  - Domestic Eng. & Pump Co.
  - General Electric Co.
  - Ingersoll-Rand Co.
  - Keystone Driller Co.
  - Sullivan Machinery Co.
  - Wood Drill Works.
- **Drill Steel Sharpeners.**
  - Ingersoll-Rand Co.
  - Sullivan Mach. Co.
- **Drills, Submarine.**
  - Ingersoll-Rand Co.
- **Dump Cars (See Cars).**
- **Dump Wagons.**
  - Acme Road Mach. Co.
  - Austin-Western Road Machinery Co.
  - Clark Tructractor Co.
  - Kilbourne & Jacobs Mfg. Co.
  - Russell Grader Mfg. Co.
  - Smith & Sons Mfg. Co.
  - Strood & Co.
  - Tiffin Wagon Co.
  - Western Wheeled Scraper Co.
- **Dust Preventive.**
  - Barber Asphalt Paving Co.
  - Barrett Co., The.
  - Standard Oil Co. (Indiana).
  - The Texas Company.
- **Dynamite and Powder.**
  - DuPont Powder Co.
  - Hercules Powder Co.
- **Dynamite Magazines, Portable Powder.**
  - Littleford Bros.
- **Electric Equipment (See Motors).**
- **Elevators; Contractors' Material.**
  - Byers Machine Co., John F.
  - Gifford-Wood Co.
  - Insley Manufacturing Co.
  - Jeffrey Mfg. Co.
  - Smith Co., T. L.
  - Thomas Elevator Co.
  - Weller Mfg. Co.
- **Ejectors (See Sewage Ejectors).**
- **Engineers' Supplies.**
  - Aloe, A. S., Co.
  - Beckman, L., Co.
  - Carpenter, Geo. B., & Co.
  - Economy Drawing Table Co.
  - Hein Furniture Co.
  - Kolesch & Co.
  - Lufkin Rule Co.
- **Engine—Gas, Gasoline, Oil.**
  - Allis-Chalmers Mfg. Co.
  - Buffalo Hoist & Derrick Co.
  - Burton Engineering & Mach. Co.
  - Chicago Pneumatic Tool Co.
  - Domestic Eng. & Pump Co.
  - Fairbanks Morse & Co.
  - Fate-Root-Heath Co.
  - Ingersoll-Rand Co.
  - Lerol Company.
  - Novo Engine Co.
  - Standard Scale & Supply Co.
  - T. L. Smith Co., The.
  - Westinghouse Electric & Mfg. Co.
  - Whitcomb, Geo. D., Co.
- **Engines—Steam.**
  - Allis-Chalmers Mfg. Co.
  - Ball Engine Co.
  - Chicago Pneumatic Tool Co
  - Dake Engine Co.
  - Erie Steam Shovel Co.
  - Ingersoll-Rand Co.
- **Excavators—Cableway.**
  - Blaw-Knox Co.
  - Flory, S., Mfg. Co.
  - Lidgerwood Mfg. Co.
  - Link Belt Co.
  - Sauerman Bros.
- **Excavators—Dragline.**
  - Austin, F. C., Mach. Co.
  - Ball Engine Co.
  - Brown Hoisting Mach. Co.
  - Bucyrus Company, The.
  - Lidgerwood Mfg. Co.
  - Monighan Machine Co.
  - McMyler Interstate Co.
  - Ohio Locomotive Crane Co.
  - Osgood Co.
  - T. L. Smith Co., The.
- **Excavators — Trench (See Ditching Machinery).**
- **Explosives (See Dynamite and Powder).**
- **Filing Cases—Office.**
  - Economy Drawing Table Co.
  - Hein Furniture Co.
- **Fans, Electric.**
  - Westinghouse Electric & Mfg. Co.
- **Filters, Feed Water.**
  - Blackburn-Smith Corp.
  - Simplex Valve & Meter Co.
- **Fire Doors, Skylights, Etc.**
  - Edwards Mfg. Co.
  - Willis Mfg. Co.
- **Forgings, Railway and Industrial.**
  - Laclede Steel Co.
- **Forms—Concrete and Cement.**
  - Blaw-Knox Co.
  - Heltzel Steel Form & Iron Co.
- **Foundations.**
  - MacArthur Concrete Pile Co.
  - Raymond Concrete Pile Co.
- **Fuses and Fuse Specialties.**
  - General Electric Co.
- **Garages for Tractors, Steel Portable.**
  - Blaw-Knox.
- **Gas Boosters.**
  - Ingersoll-Rand Co.
- **Gates—Lock.**
  - McClintic-Marshall Co.
- **Gates—Sluice.**
  - Bourbon Copper & Brass Wks.
  - Hardesty Mfg. Co.
  - Armco Iron Culvert Asso.
- **Gears, Swinging.**
  - Dake Engine Co.
- **Graders, Earth, Elevating.**
  - Acme Road Mach. Co.
  - Adams, J. D., & Co.
  - Austin Mfg. Co.
  - Austin-Western Road Mach. Co.
  - Baker Mfg. Co.
  - Koehring Machine Co.
  - Monroe, N. S., & Sons.
  - Russell Grader Mfg. Co.
  - Smith & Sons Mfg. Co.
  - T. L. Smith Co., The.
  - Western Wheeled Scraper Co.
- **Hammers, Pneumatic.**
  - Chicago Pneumatic Tool Co.
- **Headgates.**
  - Hardesty, R. Mfg. Co.
- **Hoists (See also Engines).**
  - Allis-Chalmers Mfg. Co.
  - American Cement Mach. Co.
  - Byers, John F., Mach. Co.
  - Brown Hoisting Machy. Co.
  - Buffalo Hoist & Derrick Co.
  - Carpenter, Geo. B., & Co.
  - C. H. & E. Mfg. Co.
  - Chicago Pneumatic Tool Co.
  - Dake Engine Co.
  - Flory S., Mfg. Co.
  - Dobbie Fdry. & Mach. Co.
  - Gifford-Wood Co.
  - Insley Mfg. Co.
  - Lidgerwood Mfg. Co.
  - Mead-Morrison Co.
  - Clyde Iron Works.
  - Ingersoll-Rand Co.
  - Orton & Steinbrenner Co.
  - Mead-Morrison Mfg. Co.
  - Pawling & Harnischfeger Co.
  - Roebling's Sons, John A.
  - Westinghouse Electric & Mfg. Co.
- **Hoists, Hydraulic for Motor Trucks.**
  - Heil Co., The.
- **Hose.**
  - Chicago Pneumatic Tool Co.
- **Hydrants.**
  - Bourbon Copper & Brass Wks.
  - Clark, H. W., Co.
- **Insulated Wires & Cables.**
  - Westinghouse Electric & Mfg. Co.
  - Roebling's Sons, John A.
- **Hose.**
  - Ingersoll-Rand Co.
- **Incinerators.**
  - Stacy Bates Co.
- **Inserts, Concrete.**
  - Donley Bros. Co.
- **Insultaing Materials.**
  - General Electric Co.
- **Jacks—Adjustable.**
  - Carpenter, Geo. B., & Co.
  - Duff Mfg. Co.
- **Joint Filler—Paving.**
  - Barber Asphalt Paving Co.
  - Barrett Company, The.
  - Standard Oil Co. (Indiana).
- **Joints—Expansion Paving.**
  - Barber Asphalt Paving Co.
  - Barrett Company, The.
  - Carey Co., Philip, The.
  - Robertson, H. H., Co.
  - Trus-Con Steel Co.
- **Lights, Contractors.**
  - Carpenter, Geo. B. & Co.
- **Lighting, Electric.**
  - Bucyrus Co., The.
  - General Electric Co.
  - Westinghouse Electric & Mfg. Co.
- **Lockers, Steel.**
  - Edwards Mfg. Co.
- **Locomotives.**
  - Acme Road Mach. Co.
  - Porter Co., H. K.
  - Fate-Root-Heath Co.
  - Jeffrey Mfg. Co.
  - Lakewood Engineering Co.
  - Southern Iron & Equip. Co.
  - Whitcomb, Geo. D., Co.
- **Locomotives, Electric.**
  - General Electric Co.
  - Westinghouse Electric & Mfg. Co.
- **Loaders, Bucket Elevator.**
  - Acme Road Mach. Co.
  - Atlas Engineering Co.
  - Gifford-Wood Co.
  - Heltzel Steel Form & Iron Co.
  - Jeffrey Mfg. Co.
  - Link Belt Co.
  - Weller Mfg. Co.
- **Loaders, Skip or Bin.**
  - Heltzel Steel Form & Iron Co.
  - Jeffrey Mfg. Co.
- **Lumber.**
  - Am. Oak Mfg. Assn.
  - Great Southern Lumber Co.
  - Pacific Lumber Co.
  - Southern Cypress Mfrs. Assn.
- **Magazines, Portable Powder.**
  - Littleford Bros.
- **Manhole Covers.**
  - Clark, H. W. Co.
  - Clow, James B., & Son.
  - Dobbie Fdry. & Mach. Co.
  - U. S. Cast Iron Pipe & Fdry. Co.
- **Meters and Meter Boxes.**
  - Badger Meter Mfg. Co.
  - Buffalo Meter Co.
  - Clark Co., H. W.
  - General Electric Co.
  - Pittsburgh Meter Co.
  - Pittsburgh Filter & Engineering Co.
  - Union Water Meter Co.
- **Meters, Gas and Oil.**
  - Pittsburgh Meter Co.
- **Mixers — Cement and Concrete.**
  - Acme Road Mach. Co.
  - American Cement Mach. Co.
  - Atlas Engineering Co.
  - Austin F. C. Mach. Co.
  - Badger Concrete Mixer Co.
  - Domestic Eng. & Pump Co.
  - Foote Co., The, Inc.
  - Jaeger Machine Co.
  - Judy Mfg. Co.
  - Koehring Machine Co.
  - Republic Iron Works.
  - Standard Scale & Supply Co.
  - T. L. Smith Co., The.
  - Stewart Mfg. Co.
  - Archer Iron Works.
- **Molds (See Forms).**
- **Motors, Electric, Gas.**
  - Allis-Chalmers Mfg. Co.
  - Blaw-Knox Co.
  - Domestic Eng. & Pump Co.
  - General Electric Co.
  - Le Roi Company.
  - New Way Motor Co.
  - Westinghouse Electric & Mfg. Co.
- **Motor Trucks.**
  - Acme Motor Truck Co.
  - Autocar Company.
  - Clark Tructractor Co.
  - Clydesdale Motor Truck Co.
  - Federal Motor Truck Co.
  - Kissel Motor Car Co.
  - Nelson Motor Truck Co.
  - Packard Motor Car Co.
  - Pierce-Arrow Motor Car Co.
  - Tiffin Wagon Co.
  - Titan Truck Co.
  - Traffic Motor Truck Co.
  - White Company, The.

CLASSIFIED INDEX TO ADVERTISERS

Motor Truck Bodies.
Automatic Dump Car Co.
Heil Co., The.
Kilbourne & Jacobs Mfg. Co.
Lee Loader Co.
Littleford Bros.
Standard Steel Works.

Motor Truck Tires.
Kelly Springfield Tire Co.

Municipal Castings.
South Bend Foundry Co.

Office Furniture (See Drafting Room Furniture)

Oils—Road.
Barber Asphalt Paving Co.
Texas Company, The.
Standard Oil Co. (Indiana).

Oilers, Road.
Austin-Western Rd. Mach. Co.
Kinney Mfg. Co.
Universal Rd. Mach. Co.

Oxygen.
Linde Air Products Co.

Paints and Wood Preservatives.
Barber Asphalt Paving Co.
Barrett Company, The.
Carey Co., Philip.
Carpenter, Geo. B. & Co.
Proterol Corporation.
Trus Con Laboratories

Painting Outfits, Portable.
Spray Engineering Co.

Pavement.
Willite Road Const. Co.

Paving Brick.
Delaware Clay Products Co.

Paving Guards.
Blaw Knox Co.
H. H. Robertson Co.

Paving Joints (See Joints, Paving).

Pile Drivers and Jets.
Browning Co., The.
Lidgerwood Mfg. Co.
McMyler Interstate Co
Vulcan Iron Works.

Piling—Concrete.
Massey Concrete Products Corp'n.
McArthur Concrete Pile Co.
Raymond Concrete Pile Co.

Piling Steel.
Carnegie Steel Co.
Lackawanna Steel Co.

Pipe and Fittings—Cast Iron.
American Cast Iron Pipe Co.
Carpenter, Geo. B. & Co.
Cast Iron Pipe Publicity Bureau.
Central Foundry Co.
Clow, James B., & Sons.
Donaldson Iron Co.
Hammond-Byrd Iron Co.
Lynchburg Foundry Co.
National Cast Iron Pipe Co.
Massillon Iron & Steel Co.
U. S. Cast Iron Pipe & Fdry. Co.
Warren Foundry & Machine Co.

Pipe Concrete.
Massey Concrete Products Corp'n

Pipe, Sewer—Vitrified .
Delaware Clay Products Co.

Pipe Bending Machines.
American Pipe Bending Machine Co.

Pipe Joints and Jointing.
Central Foundry Co.

Pipes—Steel.
American Spiral Pipe Co.
Blaw-Knox Co.
Fitz Water Wheel Co., The.
National Tube Co
Robertson Bros.

Pipe, Riveted.
Littleford Bros.
McClintic-Marshall Co.

Pipe, Steel Dredge.
Fitz Water Wheel Co.
Lancaster Iron Works.

Pipe—Wood.
Continental Pipe Mfg. Co.
Michigan Pipe Co.
Western Wood Pipe Publicity Bureau.
Wyckoff, A., & Sons.

Plates, Steel (See Steel).

Plows.
Adams J. D. & Co.
Austin Mfg. Co.
Russell Grader Mfg. Co.
Stroud & Co.
Western Wheeled Scraper Co.

Pneumatic Tools [illegible]
Chicago Pneumatic Tool Co.
Domestic Eng. & Pump Co.
Ingersoll-Rand Co.

Portable Conveyors (See Conveyors—Portable)

Portable Buildings (See Buildings, Portable)

Powder (See Dynamite)

Pumps.
Allis-Chalmers Mfg. Co.
American Well Works, The
Barnes Mfg. Co., The
Carpenter, Geo. B., & Co.
C. H. & E. Mfg. Co.
Chicago Pneumatic Tool Co.
Cook Co. A. D.
DeLaval Steam Turbine Co.
Domestic Engine & Pump Co.
Emerson Pump & Valve Co.
Erie Pump & Engine Co.
Ingersoll Rand Co.
Layne & Bowler
Manistee Iron Works
Morris Machine Works
Nye Steam Pump & Mach. Co
Pulsometer Steam Pump Co.
Rife Engine Co.
Sullivan Machinery Co
Talbot Air Lift Co
T. L. Smith Co., The
Taber Pump Co.
Worthington Pump & Machy Corpn
Yeomans Bros. Co.

Railway Ties, Braces, Etc.
Gillis & Co.

Ready-Built Houses.
Blaw Knox Co.

Reinforcing Steel (See Steel).

Rivet Heaters.
American Car & Foundry Co
General Electric Co.

Road Drags, Patrol Scrapers, Road Maintainers.
Acme Road Mach. Co.
Adams, J. D., & Co.
Austin-Western Road Mach. Co.
Bayne Mfg. Co.
Carpenter, Geo. B., & Co.
Clark Tructractor Co.
Russell Grader Mfg. Co.
Smith & Sons Mfg. Co.
Universal Road Mach. Co.
Western Wheeled Scraper Co.

Road Sprayers.
Austin-Western Rd. Mach. Co.
Cressy Road Sprayer Co.
Kinney Mfg. Co.

Roads and Street Preservatives (See Oils. See Asphalts).

Rollers, Road.
Austin Western Road Mach. Co.
Barber Asphalt Paving Co.
Buffalo Springfield Roller Co.
Erie Machine Shops.
Smith & Sons Mfg. Co.
Universal Road Mach. Co.
Western Wheeled Scraper Co

Roofing.
American Sheet & Tin Plate Co
Barber Asphalt Paving Co.
Barrett Company, The.
Carey, Philip, Co.
Carpenter, Geo. B. & Co
Edwards Mfg. Co
Robertson, H. H. Co
Whittaker-Gleasner Co.

Rope (See Wire Rope, also Cordage)

Rules and Tapes.
Lufkin Rule Co

Sand and Gravel Plants.
Chalmers & Williams
Link Belt Co
Russell Grader Mfg. Co.
Smith Engineering Works.

Sand Rammers
Chicago Pneumatic Tool Co.

Sash—Steel.
Carnegie Steel Co
Truscon Steel Co

Saw Rigs, Portable.
Carpenter, Geo. B., & Co.
C. H. & E. Mfg. Co.

Scarifiers.
Acme Road Mach. Co.
Adams J. D. & Co.
Austin-Western Road Machinery Co.
Buffalo Springfield Roller Co.
Russell Grader Mfg. Co.
Smith & Sons Mfg. Co.
Stroud & Co.
T. L. Smith Co., The
Universal Road Mach. Co.
Western Wheeled Scraper Co

Scrapers—Drag and Wheeled
Adams J. D. & Co.
Austin-Western Road Machinery Co.
Baker Mfg. Co.
Carpenter Geo. B. & Co.
Green L. F.
Kilbourne & Jacobs Mfg Co
Smith & Sons Mfg. Co.
Stroud & Co
Sauerman Bros.
T. L. Smith Co., The
Western Wheeled Scraper Co.

Screens, Sand, Gravel, Etc.
Acme Road Mach. Co.
Austin Mfg. Co.
Gifford Wood Co.
Jeffrey Mfg. Co
Link Belt Co.
Smith Engineering Works.
Weller Mfg. Co.

Sewage Disposal Screens.
Green Bay Fdry. & Mach. Wks

Sewage Ejectors.
Yeomans Bros. Co

Sewer Cleaning Machines.
Springfield Engineering Co.
Turbine Sewer Machine Co.

Shafting Equipment.
Link Belt Co.
Weller Mfg. Co.

Shovels (See Steam Shovels)

Shovels, Automatic Power.
Weller Mfg. Co.

Shoveling Machines.
Myers-Whaley Co

Slag.
Carnegie Steel Co.

Snow Plows.
Baker Mfg. Co.
Good Roads Mach. Co.
Russell Grader Co.
Jordan & Co., The O. F.
Phoenix Mfg. Co.

Spreaders.
Austin Western Road Machinery Co.
Jordan & Co., The O. F.
Western Wheeled Scraper Co

Sprinkling Wagons.
Acme Road Mach. Co.
Austin-Western Road Machinery Co.
Western Wheeled Scraper Co.

Steam Shovels.
Ball Engine Co
Bellwood Steam Shovel Co.
Browning Co., The
Bucyrus Co., The
Erie Steam Shovel Co.
Keystone Driller Co.
Marion Steam Shovel Co.
Osgood Co. The
Thew Automatic Shovel Co.

Steel, Hot Rolled Strips.
Laclede Steel Co

Steel—Reinforcing Concrete.
Blaw Knox Co.
Carnegie Steel Co
Lackawanna Steel Co.
Laclede Steel Co.
National Steel Fabric Co.
Ryerson, Joseph T.
Truscon Steel Co

Steel — Structural Work, Plates and Sheets, Etc.
American Sheet & Tin Plate Co.
Blaw Knox Co
Bucyrus Company
Carnegie Steel Co
Chicago Bridge & Iron Wks
Gifford-Wood Co.
Heil Co., The.
Kenwood Bridge Co
Lackawanna Steel Co.
Laclede Steel Co
Lakewood Engineering Co.
Littleford Bros.
McClintic-Marshal Co.
Memphis Steel Const. Co
National Steel Fabric Co.
Pottstown Iron Works
Pittsburg-Des Moines Steel Co.
Ryerson, Joseph T.

Steel Sash.
Truscon Steel Co

Steel [illegible]
[illegible]
[illegible]

Stakes.
[illegible] Corporation

Stone Spreaders (See Spreaders)

Street Cleaning Machinery
Austin [illegible]
Austin-Western Road Machinery Co.
Baker Mfg. Co.
[illegible]
Universal Road Mach. Co.

Surface Heaters
Equitable Asphalt Maintenance Co.

Switches, Electric
General Electric Co.
Westinghouse Electric & Mfg. Co.

Switches, Tank and Float
[illegible] Corp.

Tampers—Power
Ingersoll Eng. & Pump Co.
Pawling & Harnischfeger Co.

Tanks Towers—Standpipes.
Blaw Knox Co.
Caldwell, W. E. Co.
Chicago Bridge & Iron Co
Continental Pipe Mfg. Co.
Humborst, Joe The Co.
Lancaster Iron Works
Littleford Bros
McClintic-Marshall Co
Memphis Steel Const. Co
Pittsburg Des Moines Steel Co.

Tanks, Steel Welded, for every purpose, gasoline storage pressure and storage.
(See Steel Plate Construction).

Tar Kettles, Stationary and Portable.
Blaw Knox Co.
Humborst Jos., The, Co.
Littleford Bros
Standard Steel Works

Tents, Awnings.
Carpenter, Geo. B. & Co.
U. S. Tent & Awning Co.

Testing Instruments.

Tile, Drain, Roofing, Sewer Tile, Mains, Etc.

Tool Houses.
Littleford Bros.

Traction Engines
Allis Chalmers Mfg Co
Lakewood Engineering Co.
Austin Co., Inc., F. C.
Leroi Company.

Traction Shovels (See Steam Shovels).

Tractors.
Advance-Rumely Co
Allis-Chalmers Mfg. Co.
Archer Iron Works
Austin, F. C., Mach. Co
Avery Co
Best C. L., Tractor Co.
Cleveland Tractor Co.
Clark Tructractor Co.
Kinnard Mfg. Co
Monarch Tractor Co.
Holt Mfg. Co.
Oliver Tractor Co
Shaw Enochs Tractor Co.

Trailers.
Highway Trailer Co.
Lee Loader Co.

Transits and Levels
Aloe, A. S. Co
Beckman, L., Co.
Kolesch & Co

Transformers, Electric.
General Electric Co
Westinghouse Electric & Mfg. Co.

Traveling Cranes (See Cranes).

Tread, Safety.
Universal Safety Tread Co.

Trench Braces.
Carpenter Geo. B. & Co
Kalamazoo Fdry. & Mach. Co.

Trench Fillers (See Backfillers).

Trench Machines and Supplies (See Ditching Machines)

Trucks, Industrial.
Clark Tructractor Co.

Tunnel Lining.
Blaw-Knox Co.
Insley Mfg. Co

Turbines.
Allis-Chalmers Mfg. Co.
DeLaval Steam Turbine Co.
Fitz Water Wheel Co
General Electric Co.
Westinghouse Electric & Mfg. Co.

[illegible]
Chicago Bridge & Iron Works
Jones Mfg. Co.
Pittsburgh-Des Moines Steel Co

Unloaders, Belt or Box
Jeffrey Mfg. Co.
Weller Mfg. Co.

Valves (See also Gates)
Coffin H. W. Co
Clow James B. & Sons
Crane Co.
Emerson Pump & Valve Co
Jenkins Bros.
Kennedy Valve Mfg. Co

Valves, Foot
Emerson Pump & Valve Co
Hardesty R. Mfg. Co.
Kennedy Valve Mfg. Co

Ventilators.
Bayley Mfg. Co
Milwaukee Corrugating Co

Wagons (See Dump Wagons also see Sprinkling Wagons)

Wagon Loaders
Austin Co., Inc., F. C.
Chain Belt Co
Gifford Wood Co.
Haiss Mfg. Co., George
Jeffrey Mfg. Co.
Lee Loader Co.
Link Belt Co
Portable Machinery Co.
Russell Grader Mfg. Co

Washing Plants — Sand and Gravel.
Chalmers & Williams
Link Belt Co
Smith Engineering Works
Weller Mfg. Co.

Water Purification.
Pennsylvania Salt Mfg. Co.
Pittsburgh Filter & Engineering Co
Wallace & Tiernan Co

Water Main Cleaning
National Water Main Cleaning Co.

Water Wheels
Fitz Water Wheel Co

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
Carey, Philip Co
Proterol Corporation
Sandusky Cement Co.
The Texas Company.
Trus Con Laboratories

Welding Apparatus, Acetylene.
Oxweld Acetylene Co

Welding, Electric, Oxy-acetylene, Forge & Hammer
General Electric Co
Westinghouse Electric Mfg. Co
Prest-O-Lite Co., Inc.

Well Drilling Machinery
American Well Works
Keystone Driller Co.
Layne & Bowler.

Well Screens.
American Well Works
Cook, A. D.
Johnson Edward E., Inc.

Welding Wire.
Roebling's Sons, John A.

Wheelbarrows.
Carpenter Geo. B., & Co.
Fischer & Hayes Rope & Steel Co.
Kilbourne & Jacobs Mfg. Co

Winches.
Brown Hoisting Machine Co.
Carpenter Geo. B., & Co.
Dake Engine Co.
Dobbie Fdry. & Mach. Co
Flory Mfg. Co.
Lidgerwood Mfg. Co.
Mead Morrison Mfg. Co
Sasgen Derrick Co.

Windlasses.
Dake Engine Co
Dobbie Fdry. & Mach. Co.

Wire Rope, Fittings, Sling, Sheaves, Blocks.
American Steel & Wire Co
Bucyrus Co. The
Carpenter Geo. B. & Co.
Dobbie Fdry. & Mach. Co
General Electric Co
Leschen & Sons Rope Co
Roebling's Sons, John A
Sauerman Bros
Waterbury Company
Williamsport Wire Rope Co

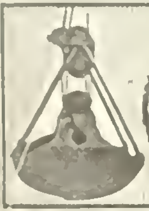
Wood Borers, Portable and Electric.
Chicago Pneumatic Tool Co.

Wood Preservatives (See Paints and Wood Preservatives. See also Creosoted Blocks).

Wrenches
Wrenches, Alligator
Roebling's Sons, John A

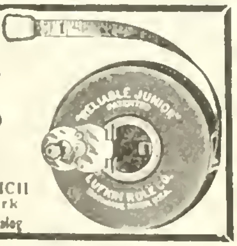
RAILROAD CROSS TIES
Switch Ties
Plank Timbers
ESTABLISHED 18?2
GILLIS & COMPANY
8 So. Wabash Ave.,
CHICAGO

AMERICAN CAST IRON PIPE COMPANY
MANUFACTURERS OF
CAST IRON PIPE AND FITTINGS
BIRMINGHAM, ALA.
Birmingham, Ala.—Box [illegible]
[illegible], Ohio—[illegible]7 New Hayden Bldg.
Minneapolis, Minn.—712 Plymouth Bldg.
Chicago, Ill.—512 1st Nat. Bk. Bldg.
Dallas, Tex.—1217 Praetorian Bldg.
Kansas City, Mo.—710 Scarritt Bldg.
San Francisco, Cal., 711 Balboa Bldg.
Los Angeles, Cal.—433 East Third St.
New York City—261 Broadway



"Aden" Grab Buckets
[illegible]
Write for further information
THE ADVANCE ENGINEERING CO.
Offices: 6543 Metta Street
Cleveland O.

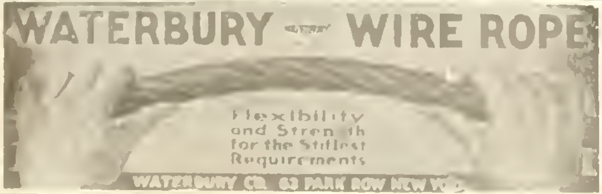
THE PILE WITH A BIG FOOT
MacARTHUR PEDESTAL PILE
The MacArthur Method of forming the Spread Base and compressing the uniform diameter Concrete Shaft insures maximum Foundation Safety under every working condition and in all kinds of soil
Complete information on request
MacARTHUR CONCRETE PILE & FOUNDATION CO.
CHICAGO NEW YORK 12 John St PHILADELPHIA
Canadian MacArthur Concrete Pile Co., Ltd 10 Cathcart St
Montreal P. Q.



LUFKIN TAPES
WITH
Instantaneous
Readings
PIONEERS AND LEADERS OF THE FIELD
DISTINCTIVE IN QUALITY
THE LUFKIN RULE Co. SAGINAW, MICH
New York
Send for catalog

DE LAVAL GEARED STEAM-TURBINE-DRIVEN CENTRIFUGAL PUMPS
FOR WATER WORKS SERVICE
[illegible] duty records for this type of pumping unit. We refer to notable installations at Pittsburgh, Cleveland, Toronto, Montreal, Philadelphia, St. Louis. Because of the reduced cost of machinery, foundations and buildings and high over-all efficiency, they give the lowest total cost of pumping water, [illegible] and all heads. Ask for "Progress in Water Works Pumping Equipment."
DE LAVAL STEAM TURBINE CO. TRENTON, N. J.

EMERSON STEAM PUMPS
EMERSON FOOT VALVES AND STRAINERS
For Contractors, Mines, Quarries, Cofferdams, and all Rough and Ready Service. *Immediate Deliveries.*
The Emerson Pump & Valve Co., Inc.
ALEXANDRIA, VA.



WATERBURY WIRE ROPE
Flexibility and Strength for the Stiffest Requirements
WATERBURY CO. 63 PARK ROW NEW YORK

Steel Bridges & Buildings
McClintic-Marshall Co.
Pittsburgh

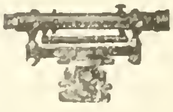
Centrifugals
Send for Catalogs describing the Taber "V" Type Volute Belt Driven Centrifugal Pumps, made in sizes from 1" to 6", also our "Tablige" Hand Force Pumps.
TABER PUMP COMPANY
299 Elm St., Buffalo, N. Y.

Erie Tandem Rollers
Built by
ERIE MACHINE SHOPS
Erie, Penna.
Catalogue on Request

Use LACLEDE BARS
For Reinforcing Concrete
Manufactured by
LACLEDE STEEL COMPANY, St. Louis, Mo.
Works at Madison, Ill., Alton, Ill.

Thew
Power Shovels
THE THEW SHOVEL COMPANY LORAIN OHIO

BELLWOOD STEAM SHOVELS
Combine Power, Durability, Efficiency and Economy
They're as good as it is possible to make them, and we can prove it by actual tests
Full information and prices mailed on request.
THE BELLWOOD STEAM SHOVEL CO. Inc.
BELLWOOD, PA.
Philadelphia Sales Office:
J. M. Reed Co. Inc., 516 Commercial Trust Bldg



White's famous improved Convertible Level
from our factory to You
Ten Days' Free Trial
DAVID WHITE COMPANY
Corner Ninth and Chestnut Sts. MILWAUKEE, WIS.

VULCAN IRON WORKS
327 NO. IRVING AVE. CHICAGO
PILE DRIVERS

173098

Engineering and Contracting.
54 (1920)

P
Tech
E

University of Toronto
Library

DO NOT
REMOVE
THE
CARD
FROM
THIS
POCKET

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU